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Assessment of 24 Selected Waste Disposal Sites in Manitoba

Manitoba
Environment and
Workplace Safety
and Health

MG 1309

ASSESSMENT OF 24 SELECTED WASTE DISPOSAL SITES IN MANITOBA

PHASE II MANITOBA LANDFILL STUDY

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for
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ENVIRONMENT CANADA

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SUMMARY

Across Canada, a number of three phase waste disposal site environmental assessment projects, now in various stages of completion, have been jointly undertaken by the Federal and Provincial Governments.

In 1984, the Manitoba Phase Two assessment of 24 waste disposal sites was undertaken. The sites investigated included: Austin, Benito, Boissevain, Carberry, Crystal City, Darlingford, Deloraine, Gimli, Gilbert Plains, Glenboro, Hartney, Killarney, Minitonas, Morden, Munro Farm Supply Ltd. agricultural container compound in Westbourne, Parks Branch Campgrounds of Lynch Point and Stephenfield, Sidney, Somerset, Souris, The Pas Indian Reserve, Traverse Bay, Treesbank and Winkler.

For each of the selected sites, a site inspection and a technical data review was carried out. Further investigation included one or more of the following: test hole drilling, the installation of monitoring wells, the installation of methane gas probes, and the sampling of residential wells.

The sites of Gilbert Plains, Souris and Hartney were found to have a low impact on the environment, however, operational practices can be improved, and recommendations were made accordingly.

The sites of Carberry, Glenboro, Sidney, Morden, Austin, Benito, Minitonas, Traverse Bay and Killarney were found to have varying degrees of impact on the environment, ranging from low to moderate. It should be noted that no serious environmental problems were detected, however, continuing monitoring of the wells and probes should be conducted. It is further recommended that additional monitoring wells be installed at several of the sites.

The Gimli Waste Disposal site is contaminating the shallow aquifers and surface waters in the area and poses a major environmental impact to the environment. It is recommended that this site be properly closed and a new site established.

INTRODUCTION

Throughout Canada, joint projects between Provincial Environmental Agencies and the Federal Environmental Protection Service, to evaluate land disposal sites have been undertaken because of concerns with public health and environmental problems.

In Manitoba, 760 active and inactive waste disposal sites were identified in the 1982 I.D. Systems Report "Identification and Verification of Active and Inactive Land Disposal Sites in Manitoba". Twenty one of these sites received phase II investigation in 1983. An additional 24 sites were chosen in 1984 for phase II investigations.

The objective of the phase II study for 1984 was to investigate the waste disposal sites in order to determine their potential impact on the environment. These investigations included:

1. A site inspection.
2. Confirmation of location.
3. Air photo and map interpretation.
4. Hydrogeological interpretation.
5. Test hole drilling, monitoring well and/or methane probe installation where applicable.
6. Monitoring of groundwater, surface water and methane probes if applicable.
7. Interpretation and evaluation of all data collected.

Site inspections were conducted in September and October, 1984. Drilling was undertaken in November and water sampling of monitoring and residential wells was undertaken in December, 1984 and January, 1985, and methane probe monitoring was undertaken in January, 1985.

Chemical analysis results of water samples taken was compared to recommended levels in the Guidelines fcr Canadian Drinking Water Quality 1978.

CHAPTER - ONE -

AUSTIN

R.M. North Norfolk

SW 19-11-11W

1 AUSTIN WASTE DISPOSAL SITE

1.1 RECONNAISSANCE DATA

1.1.1 LOCATION

The Town of Austin, Manitoba, is located within the R.M. of North Norfolk, 114 Km west of Winnipeg along the Trans-Canada Highway. The waste disposal site is located 2.5 Km southwest of the town on Section SW 19-11-11W, (See Figure 1.1).

1.1.2 PHYSIOGRAPHY

The area is located at the toe of the proglacial Assiniboine Delta. The edge of the delta consists of sand deposits overlying the adjacent basin silts. Extensive channels are cut into these delta sands, leaving outwash and misfit channel cuts at the delta toe. The site is situated on an ancient meander flat of the Squirrel Creek channel. Delta sand outwash covers most of the site and a nearby sand pit.

Oak, maple and poplar trees form the vegetation along the channel bank. Willows, brush and swamp grasses, cover the channel bed. Thick, dry grass covers much of the open meander flat on the site.

Drainage on the site is towards the north into Squirrel Creek. Runoff streamlets do not exist because ground infiltration of precipitation is very rapid, allowing subsurface runoff.

1.1.3 BACKGROUND

This waste disposal site has been operating on the meander flat for over 15 years. Historically, refuse was dumped on and over the north channel bank. Bulky metallic wastes, overgrown with vegetation are still evident on this part of the site. Some 400 m west of the site, part of the meander flat has been excavated as a municipal sand pit, while other parts of the area remain unused.

In 1977, the site was registered with the Province of Manitoba as an existing waste disposal site. Present records show that this site serves approximately 900 people. Primarily municipal waste from the Town of Austin and household waste from surrounding rural areas are deposited at this site.

The Town of Austin's water treatment intake is located approximately 6 Km downstream of the disposal site, treated water from Squirrel Creek provides the public water supply for the Town of Austin. Rural residents derive groundwater from sand aquifers in the area for household and livestock requirements. Other major water users are not reported in the district.

1.1.4 SITE CONDITION

During the site inspection on September 11, 1984, several observations were made. The site is located 200 m north of the Section Road which runs east from P.T.H. 34, and 1.6 Km south of the town, as shown on Figure 1.1.

The access road winds north, then west onto the site. The active site area is approximately 125 m by 125 m, consisting of a trench and an open disposal area. The trench, about 60 m by 3 m by 3 m in size, is used for most of the disposed waste including steel drums and other metallic waste. Waste is commonly placed along the edge of the trench to be partially burnt and eventually pushed in and backfilled. Around the west end of the trench, bush and tree cuttings are deposited on the surface. An area for agricultural chemical containers is fenced on three sides and posted with signs; however, this area is immediately next to the trench and some containers were observed on the trench floor.

The location of the site is good. Natural boundaries of the tree lined channel banks and fences on the site periphery adequately confine this area. The nearest dwelling is located over 700 m west of the site with only agricultural land use around the site. Access to the site appears to be adequate in all seasons and general upkeep of the site is followed. Overall, the site is in fair condition.

1.1.5. DRILLING AND SAMPLING

Three hand auger monitoring wells were installed on October 05, 1984. All three are located 3-4 metre below the site in Squirrel Creek Channel as indicated on Figure 1.1. Soil logs are summarized in the Table 1.2.

Due to frozen well conditions, no samples were taken.

1.2 GEOLOGIC DATA

1.2.1 GEOLOGIC SETTING

The area is located on the northeastern edge of the proglacial Assiniboine Delta. Surficial sands and silts overly very thick lacustrine silts and clays with sand layers. Dense till with confined sand and gravel lenses seperate the lacustrine deposists from bedrock.

The adjacent sand pit is situated in a remnant outwash fan of Squirrel Creek. Large cross-bedding in yellow deltaic sand is visible. The banks of the creek channel, cut 4-5 metres into surrounding deposits show hard, yellow clay underlying the sands. The disposal trench exposes the clay at 1.5 metres beneath the surface (Figure 1.2).

1.2.2 BEDROCK

The bedrock underlying this area consists primarily of shales from the Jurassic Period. These shales are frequently interbedded with other sedimentary rocks such as thin sandstone, limestone and gypsum layers.

The eroded bedrock surface has been logged at a depth of around 95 metres in this area.

1.2.3 OVERBURDEN

A total of approximately 95 metres of overburden cover the underlying bedrock. About 25 metres of glacial till forms the lower sediment unit.

Overlying glaciolacustrine deposits consist of about 70 metres of clays, silts and sands. Surficial deltaic and outwash sands compose the upper 2-4 metres beneath the site area. Alternate layers of mainly plastic grey clay, silty brown clay and silty sand underly the surficial sands (Figure 1.3).

1.2.4 GEOHYDROLOGY

Water tables in the area are 3-12 metres below the site elevation and less than 1 metre below the channel bed. The primary hydraulic gradient follows the surficial and bedrock topography in a northeasterly direction along permeable strata.

The surficial sand unit forms small, shallow, unconfined aquifers in some locations. Silt and sand lenses, layered in the underlying lacustrine clay units form confined aquifers at depth.

Direct recharge of the unconfined aquifer occurs by infiltration of precipitation into the surficial sand unit. Most wells in the area are set at depth into the semi-confined and confined aquifers because the shallow sands supply insufficient quantities of water.

1.3 ENVIRONMENTAL INTERPRETATION AND ASSESSMENT

1.3.1 LEACHATE HYDROLOGY

Two sources for leachate production exist on the site; previous disposal of scrap metal on the north side of the site, and the active disposal trenches. Both areas are located well above the groundwater table, and thus, leachate infiltration occurs only by annual precipitation.

The trench areas are underlain by low permeability brown clay and silty clay. Upon downward migration of leachates, the clay absorbs moisture and becomes increasingly less permeable. Further, contaminants and infiltration are forced north, through the sand unit, into the Squirrel Creek channel alluvium.

The extent of the leachate migration is unknown; but, due to the slow infiltration process, and the underlying clay units, the groundwater affected is limited. Potentially affected are the saturated sands in the channel alluvium within several hundred metres downstream of the site. No wells or dugouts are located in this part of the channel, and the town water supply is 6 Km downstream and should not be affected.

1.3.2 METHANE

Based on the amount of waste deposited, an estimated 3 million cubic metres of methane gas may be generated per year. Since most of the organic waste is burned before burial and the site is dry, the actual amount of methane generated will only be a fraction of the estimate. Migration of gas from the site should be limited to 30-50 metres, based on the permeability of the sediments.

1.3.3 WATER QUALITY

No water samples were taken at this site. In general the sediments in this area have a moderate capacity to absorb cations, based on the clay percentage. Since leachates migrate along sand layers in the direction of the river, the actual amount of attenuation of contaminants that can occur is limited, due to the absence of clay in the sand.

The water quality of the unconfined sand and gravel aquifers in the area is considered good. The prominant features of the water in this region are the high sulphates and high carbonate content.

1.3.4 CONCLUSION

Based on the data available to date, the environmental impact of this site is moderate. The potential of groundwater contamination in the Squirrel Creek channel alluvium, and associated unconfined shallow aquifers is high. The potential for contamination in deeper aquifers decreases with depth and distance from the site.

Since the disposal area and the dump trenches are located well above the groundwater table, contaminant mobilization is limited to infiltration. Further, the site serves a small population of 900 people; and, no wells are reported on the assumed contaminant path for some distance.

Methane generation and migration is not a problem at this site since no buildings are located near the disposal area.

1.3.5 RECOMMENDATIONS

a) Since the potential for local groundwater contamination in the channel alluvium is high, no liquid waste should be disposed on this site. A sign indicating this limitation should be posted.

b) Continuation of shallow trench disposal above the groundwater table is recommended. However, trenches should be located at least 15 metres from the agricultural chemical container area and at least 30 metres from the channel bank.

c) A separate area on the site for bulky metallic waste and shrubs is desireable.

d) The three hand auger wells installed around the site should be sampled in late spring, when infiltration rates are high. The results will serve as future monitoring reference in assessing water quality in the Squirrel Creek alluvium around the site.

e) Residential wells on Section 19-11-11W should be sampled.

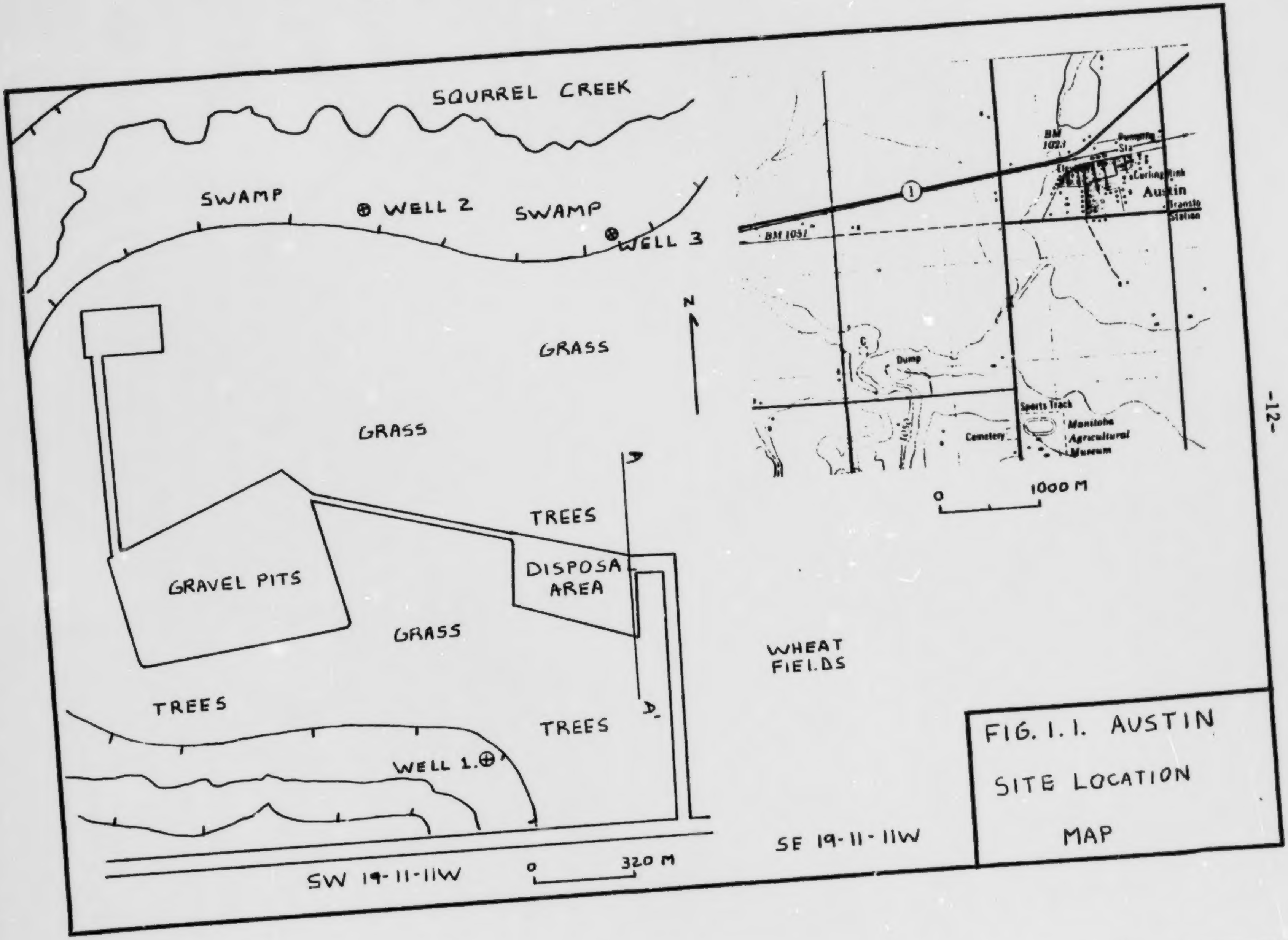

SQURREL CREEK
SWAMP
WELL 2
SWAMP
WELL 3
N
GRASS
GRASS
TREES
DISPOSA AREA
GRAVEL PITS
GRASS
TREES
TREES
WELL 1.
WHEAT FIELDS
SE 19-11-11W
SW 19-11-11W
0
320 M
0
1000 M
BM 102.1
Pumping Sta
Curling Rink
Austin
Transfo Station
1
BM 1051
Dump
Sports Track
Cemetery
Manitoba Agricultural Museum

FIG. 1.1. AUSTIN SITE LOCATION MAP

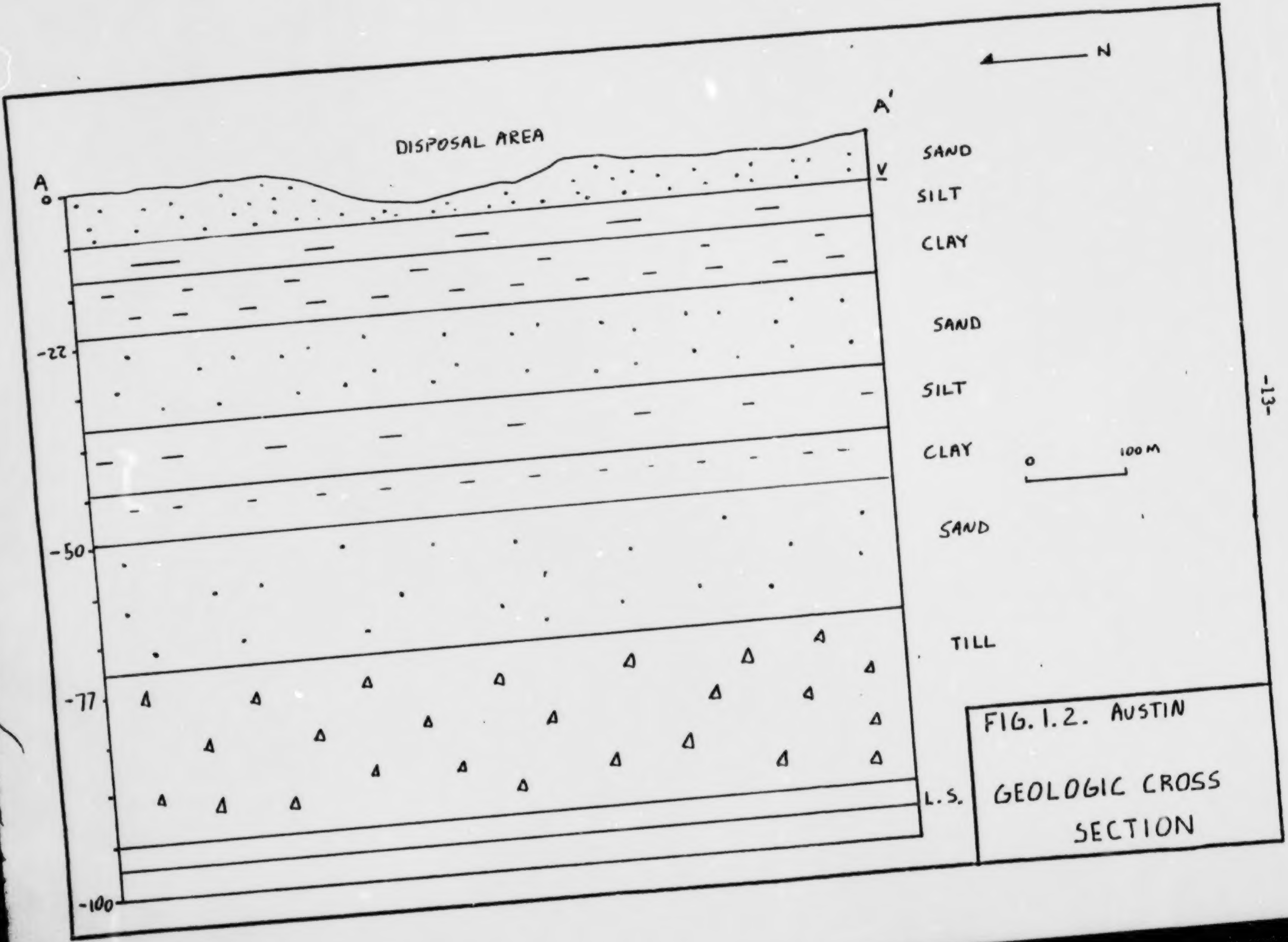

N
A'
A
DISPOSAL AREA
V
SAND
SILT
CLAY
SAND
SILT
CLAY
SAND
TILL
L.S.
0
-22
-50
-77
-100
0
100 M

FIG. 1.2. AUSTIN

GEOLOGIC CROSS SECTION

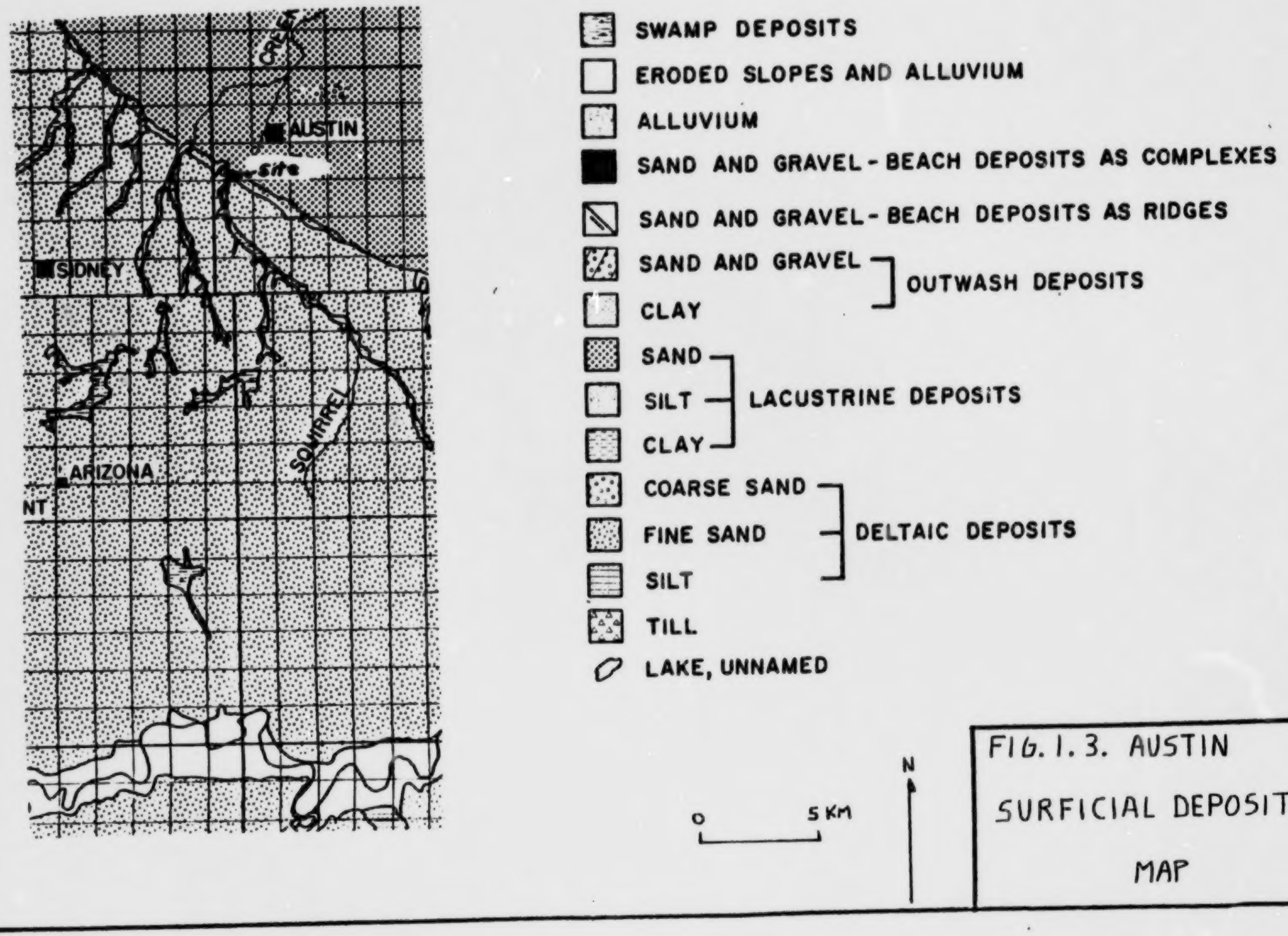

CREEK
AUSTIN
site
SIDNEY
ARIZONA
NT
SQUIRREL
▨ SWAMP DEPOSITS
☐ ERODED SLOPES AND ALLUVIUM
▨ ALLUVIUM
■ SAND AND GRAVEL - BEACH DEPOSITS AS COMPLEXES
▧ SAND AND GRAVEL - BEACH DEPOSITS AS RIDGES
▨ SAND AND GRAVEL
▨ CLAY
OUTWASH DEPOSITS
▨ SAND
▨ SILT
▨ CLAY
LACUSTRINE DEPOSITS
▨ COARSE SAND
▨ FINE SAND
▤ SILT
DELTAIC DEPOSITS
▨ TILL
LAKE, UNNAMED
0
5 KM
N

FIG. 1. 3. AUSTIN SURFICIAL DEPOSITS MAP

TABLE 1.1 AUSTIN SOIL LOGS

WELL #	DEPTH (METRES)	DESCRIPTION
1	0 - 0.3	topsoil
	.3 - 1.9	silty clay
2	0 - 0.6	organic sandy silt
	0.6 - 1.8	clayey sand
3	0 - 0.6	organic sandy silt
	0.6 - 1.8	clayey sand

CHAPTER - TWO -

BENITO

R.M. OF SWAN RIVER

SW 18-34-29W

2 BENITO WASTE DISPOSAL SITE

2.1 RECONNAISSANCE DATA

2.1.1 LOCATION

The Town of Benito is located in the R.M. of Swan River and is approximately 350 Km northwest of Winnipeg, along P.T.H. 83. The site is located 1 Km west of town, on Section SW 18-34-29W. (Figure 2.1).

2.1.2 PHYSIOGRAPHY

The area lies in an ancient deltaic plain and is dominated by rolling sandflat topography. The area shows moderate relief as reflected by two creeks located several kilometers east and west of the site. Directly north of the site, a localized depression shows seasonal ponding.

Regional drainage is into the Swan River, while local drainage is into the depressional area north of the site.

Agricultural fields dominate the area around the site. The site and the adjacent marsh support bush and grass vegetation.

2.1.3 BACKGROUND

The waste disposal ground has been closed for over 5 years. In 1977, the site was registered with the Province as an existing waste disposal ground. Records show this site served approximately 900 people. Primarily municiple waste from the Town of Benito and household waste from surrounding rural areas was deposited at this site.

Water supply for the Town of Benito is derived from a series of wells located several kilometers north of the town. Residents around the town derive water from private shallow wells. The area is served by a two cell sewage lagoon which discharges in the Lobstick Creek.

2.1.4 SITE CONDITIONS

During the site inspection on September 20, 1984, several observations were made. The site is located 100 metres north of the Section Road, and is 160 by 160 m in size. The site is inactive and the land was sold to the nearby farm. Currently the site is covered with grassy vegetation. However, several car and truck bodies still are in evidence.

The nearest dwelling to this inactive site is 500 metres to the east.

2.1.5 DRILLING AND SAMPLING

Three hand augered wells were installed on October 10, 1984. The wells are located on Figure 2.1 and soil logs summarized in Table 2.2. No water samples were taken from these wells during a routine sampling visit on December 05, 1984 due to frozen wells.

Water samples from three residential wells were sampled and analyzed. The samples are numbered 4, 5 and 6 and located on Figure 2.1. The water quality is discussed in Section 2.3.3 and the results summarized in Table 2.1.

2.2. GEOLOGIC DATA

2.2.1 GEOLOGIC SETTING

The area is located on a small proglacial delta. Historically, the delta deposited silts and sands eroded from the Duck Mountains and deposited them when entering glacial Lake Agassiz in the lowland basin.

The deltaic sand which forms the surficial deposit in this area is underlain by more impermeable strata. This can result in perched water tables forming sandy sloughs and shallow surficial aquifers in the delta (see Figure 2.2).

2.2.2 BEDROCK

The bedrock consists of various shales from the Cretaceous Period. The depth to bedrock is approximately 15 metres.

2.2.3 OVERBURDEN

Two distinct units of overburden form about 15 metres of bedrock cover. The lower unit consists of highly calcarious glacial till overlain by a deltaic sediment unit.

The deltaic sediments consist in general of interbedded clays and silts at depth, becoming coarser and more permeable near the surface. The surficial layer consists of coarse grain sand (see Figure 2.3).

2.2.4 GEOHYDROLOGY

The deltaic sediment unit forms the major aquifers in this area. Wells are set into the shallow unconfined surficial sands and into interbedded sand layers at depth.

The deeper sand units are usually partially confined by overlying clays. Recharge of these layers occurs in the Duck Mountains to the southwest of the site. The surficial sand aquifer is recharged directly by infiltration of precipitation around the site. The water table, as evident from the adjacent marsh, is near the surface.

2.3 ENVIRONMENTAL INTERPRETATION AND ASSESSMENT

2.3.1 LEACHATE HYDROLOGY

Since the sand unit beneath the site forms an unconfined aquifer, this area is pollution sensitive. Precipitation and naturally high water tables allow leachates to be generated from the waste and dispersed into the aquifer. Contamination of groundwater beneath and around the site is likely.

Cumulation of contaminants should be highest directly atop the first impermeable clay layer beneath the site. Leachate concentrations are assumed to be lower near the surface and decrease rapidly laterally away from the site.

2.3.2 METHANE

Based on the amount of waste deposited an estimated 5 million cubic metres of methane gas may be generated per year at this site.

The migration distance of any methane gas is estimated to be 50 metres, based on the permeability of the soil.

2.3.3 WATER QUALITY

Water quality analysis of the three water samples taken in the site area does not indicate signs of contamination caused by the landfill.

Analysis of sample four indicates good quality water. Sample five and six can be considered fair quality water. Both samples, five and six, have manganese levels higher then the maximum recommended concentrations. This is probably natural in occurrence and does not pose a health hazard, but is aesthetically unpleasing.

2.3.4 CONCLUSION

This inactive waste disposal site is situated on a pollution sensitive aquifer. Localized contamination of part of the aquifer, especially beneath and immediately around the site is likely. Since no wells exist in the vicinity of the site, drinking water and residential water supplies should not be affected. The residential wells sampled were of fair to good water quality and showed no elevated level of constituents attributable to the disposal site.

2.3.5 RECOMMENDATIONS

a) The wells installed at the site should be sampled to assess the water quality in the marsh.

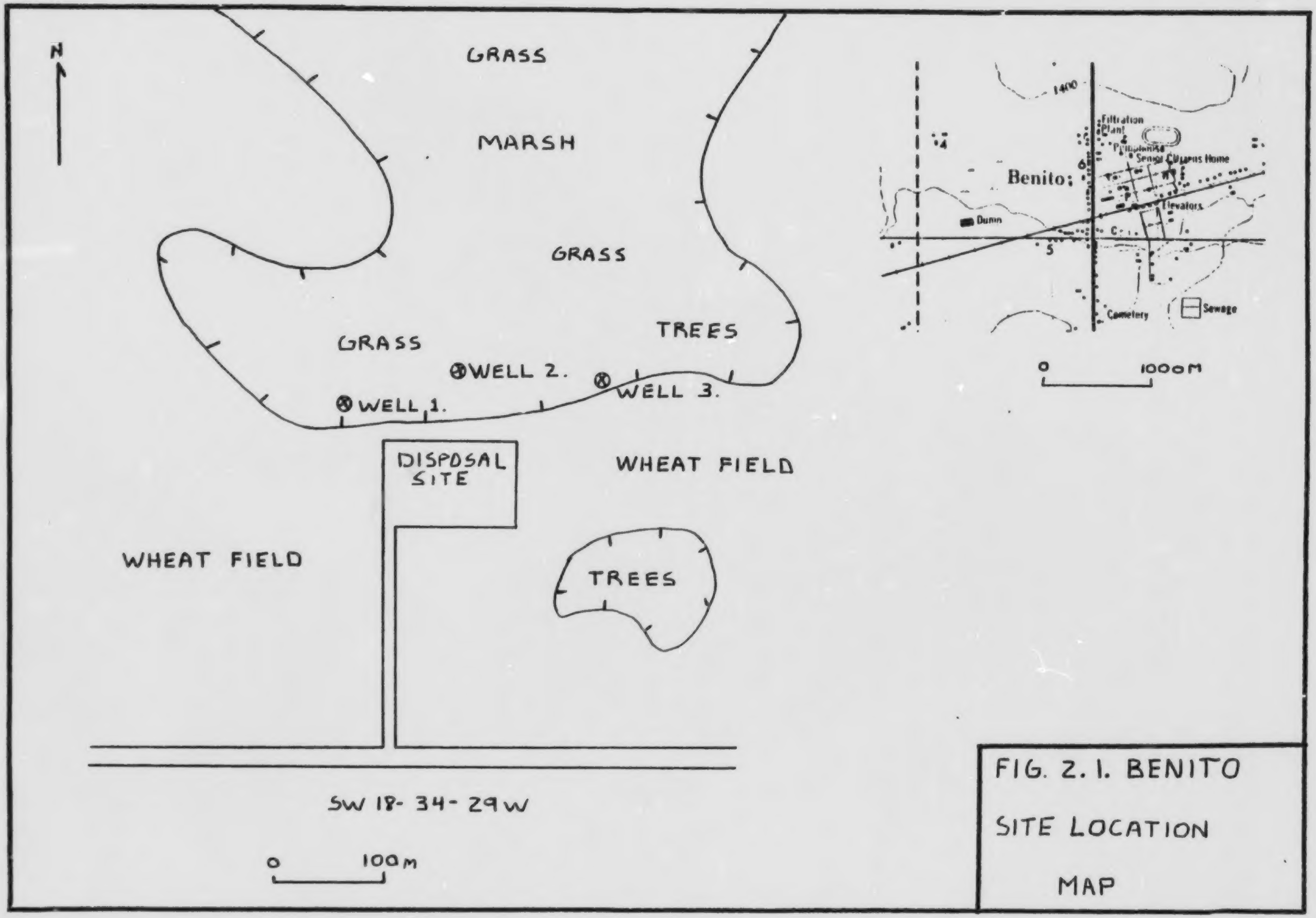

N
GRASS
MARSH
GRASS
GRASS
TREES
WELL 1.
WELL 2.
WELL 3.
DISPOSAL SITE
WHEAT FIELD
WHEAT FIELD
TREES
SW 18- 34- 29 W
0
100 m
1400
Filtration Plant
Senior Citizens Home
Benito;
6
4
5
Dunn
Elevators
C
Cemetery
Sewage
0
1000 M

FIG. 2.1. BENITO SITE LOCATION MAP

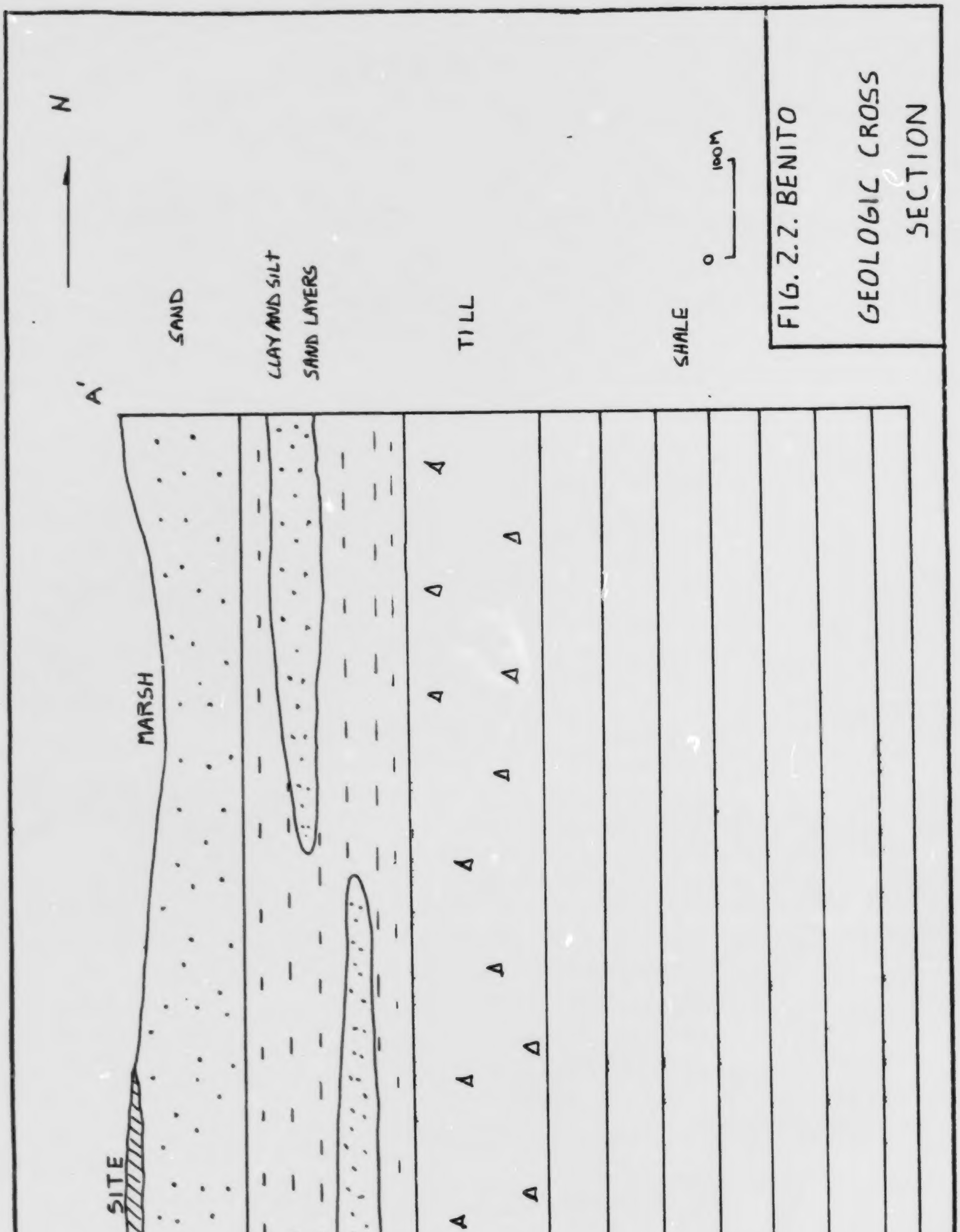

A
A'
SITE
MARSH
SAND
CLAY AND SILT
SAND LAYERS
TILL
SHALE
N
0
100M
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
metres

FIG. 2.2. BENITO GEOLOGIC CROSS SECTION

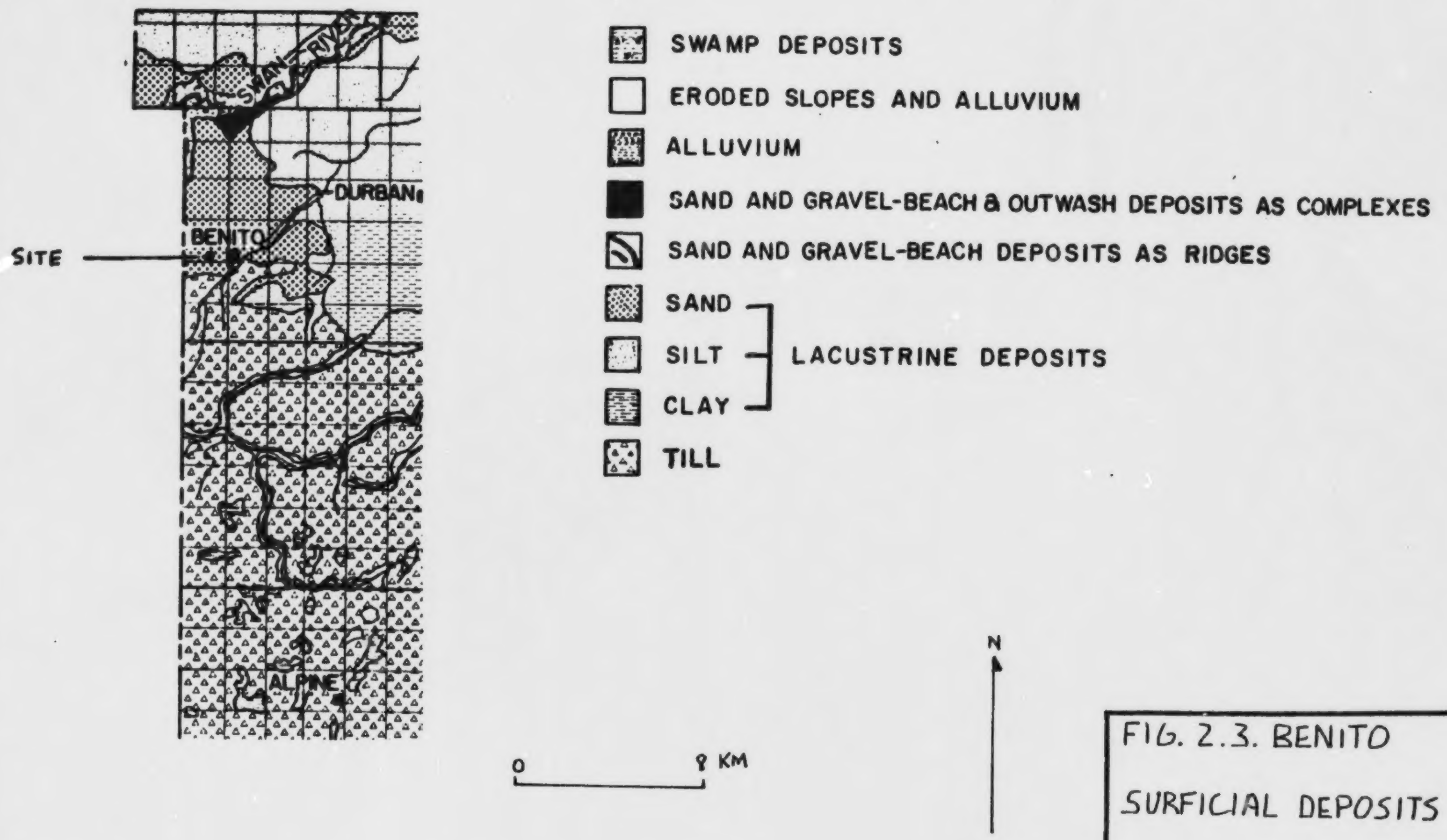

SWAN RIVER
DURBAN
BENITO
SITE
ALPINE
SWAMP DEPOSITS
ERODED SLOPES AND ALLUVIUM
ALLUVIUM
SAND AND GRAVEL-BEACH & OUTWASH DEPOSITS AS COMPLEXES
SAND AND GRAVEL-BEACH DEPOSITS AS RIDGES
SAND
SILT
CLAY
LACUSTRINE DEPOSITS
TILL
0
8 KM
N

FIG. 2.3. BENITO
SURFICIAL DEPOSITS
MAP

TABLE 2.1. BENITO

Site Number	4	5	6	
Parameters				
Conductivity umho/cm	881	1200	1510	
Residue Total mg/L	600	890	990	
Residue Filt mg/L	600	880	990	
Residue Non-Filt mg/L	<5.	6	<5.	
pH units	7.55	7.50	7.25	
Alkal. Total ($CaCO_3$)mg/L	348	382	438	
Alkalinity (HCO_3) mg/L	425	466	534	
Alkalinity (CO_3) mg/L	0	0	0	
Alkalinity (OH) mg/L	0	0	0	
As (Ext.) mg/L	<.001	<.001	<.001	
Cd (Ext.) mg/L	<.001	<.001	<.001	
Cu (Ext.) mg/L	.08	.01	<.01	
Pb (Ext.) mg/L	<.005	<.005	<.005	
Ni (Ext.) mg/L	<.005	.014	.005	
Zn (Ext.) mg/L	.04	.02	.04	
Cr (Total) mg/L	<.005	.011	<.005	
Calcium (Ext.) mg/L	85.1	156	192	
Magnesium (Ext.) mg/L	42.6	49.6	60.9	
Hardness ($CaCC_3$) mg/L	387	593	730	
Manganese (Ext.) mg/L	<.02	.39	.51	
Iron (Ext.) mg/L	<.02	.11	.28	
Potassium (Ext.) mg/L	<5.	6.00	<5.	
Sodium (Ext.) mg/L	30.9	46.2	24.3	
COD mg/L	12	42	14	
T.O.C. mg/L	8	23.5	10	
Turbidity NTU	.20	.90	1.5	
CN (Free) mg/L	<.02	<.02	<.02	
Kjeldnal, Total-N mg/L	.20	.90	.20	
NH_3-N (Sol.) mg/L	.03	.04	.03	
NO_3-NO_2-N (Diss.) mg/L	1.4	1.10	.08	
P-Total mg/L	<.01	.01	.01	
Chloride (Sol.) mg/L	26	25	260	
Sulphate (Sol.) mg/L	125	265	50	
Fecal Coliform /100 mL				
Total Coliform /100 mL				

TABLE 2.2 BENITO SOIL LOGS

WELL #	DEPTH (METRES)	DESCRIPTION
1	0 - 0.6	sandy organic peat
	0.6 - 1.8	clayey sand
2	0 - 0.6	sandy organic peat
	0.6 - 1	coarse sand
	1 - 1.5	hard clay
3	0 - 1	top soil: silty sand
	1 - 2	coarse sandy

CHAPTER - THREE -

BOISSEVAIN

R.M. OF MORTON

NE 13-3-20W

3 BOISSEVAIN WASTE DISPOSAL SITE

3.1 RECONNAISSANCE DATA

3.1.1 LOCATION

The Town of Boissevain is located in the R.M. of Morton, and is approximately 214 Km west southwest of Winnipeg along P.T.H. 10. The waste disposal site is located about 900 metres southwest of town on Section NE-13-3-20W (Figure 3.1).

3.1.2 PHYSIOGRAPHY

The area is located on the edge of till plain lowlands rising to the south onto the Turtle Mountain uplands. The till plains to the north consists of gently rolling prairies with a large number of stagnant surface waters, ponds, and seasonal sloughs. The upland slopes feature rolling hills carved by glacial and postglacial channel cuts and erosion.

The disposal site is located in a shallow, abandoned alluvial channel. Stagnant ponds to the east and west of the site lie in the remnant channel. Surface runoff from the site is into these ponds.

Vegetation on the open prairie is primarily agricultural. The site area vegetation is mostly hay and pasture grassland, with swamp reeds and grasses in sloughs and surrounding ponds. Tree growth is absent in the area of the site.

3.1.3 BACKGROUND

This waste disposal site has been operating on this location for over 70 years. In 1977, the site was registered with the Province as an existing waste disposal ground. Records show that this site serves a population of 2200 people. Primarily municiple waste from the Town of Boissevain and household waste from surrounding rural areas is deposited at this site. A trench system is reported as the disposal method.

Approximately 1 Km southwest of the waste disposal site, water is pumped from the Boissevain reservoir. The treated water supplies 1500 local residents while rural residents own private wells. The town is also served by a 2 cell sewage lagoon which discharges into Cheery Creek southwest of the town.

3.1.4 SITE CONDITIONS

During the site inspection on September 13, 1984, several observations were made. The site is located 1 Km southeast of town and is 360 metres south of P.R. 443. The site covers an area of 250 m by 160 m, with an active area of 75 m by 25 m. Waste is deposited in a trench 20 m by 7 m by 3 m deep, burned, and buried when the trench is full. The trench is located on a built up mound area several metres above grade.

Separate metallic waste and agricultural chemical container areas exist and there is evidence of burning in the chemical container compound. The site is fenced on three sides and is generally well kept; however, the nearest residence is located only 300 metres north of the site.

3.1.5 DRILLING AND SAMPLING

A drilling program was not undertaken at this site.

A water sample of the adjacent pond was taken on December 12, 1984 and submitted for analysis. Results can be found in Table 3.1 and a discussion found in Section 3.3.3.

3.2 GEOLOGIC DATA

3.2.1 GEOLOGIC SETTING

The site location is part of the extensive till plain which covers most of southwestern Manitoba. The glacial till was deposited atop the bedrock by ice sheets which advanced throughout North America.

Inclusions of sand and gravel lenses are common in the otherwise dense and impermeable drift. Saturation of these lenses form numerous aquifers which serve as water supplies for the rural population (see Figure 3.2).

3.2.2 BEDROCK

Shale and siltstone bedrock from the Cretaceous Period underlies the site at a depth of about 25 metres. Fractured and saturated zones in the bedrock are common in most areas.

3.2.3 OVERBURDEN

Approximately 25 metres of glacial clay till forms the overburden in this area. A thin layer of silty alluvium overlie the till in sloughs and channels (see Figure 3.3).

3.2.4 GEOHYDROLOGY

Two types of aquifers exist in this area. Water bearing fracture zones in the bedrock form aquifers confined by impermeable till. Confined lenses of saturated sand and gravel in the till form the other aquifer type.

Rural users draw water from the sand and gravel if present and from bedrock if necessary, but no wells are reported within 1 Km of the site.

3.3 ENVIRONMENTAL INTERPRETATION AND ASSESSMENT

3.3.1 LEACHATE HYDROLOGY

Leachate on this site is generated by precipitation infiltrating the buried waste. Due to the low permeability of the underlying till, the migration of leachate is not likely to enter the subsurface beyond a few metres in depth. Consequently, the possibility of groundwater contamination is low, and since no wells exist in the area, drinking water should not be affected.

Runoff from the site may allow sporadic contamination of the pond adjacent to the site during periods of snowmelt and major precipitation. A ditch running along the south and west side facilitates this process.

3.3.2 METHANE

Based on the amount of waste deposited at this site, an estimated 12 million cubic metres of methane gas may be produced per year. Since the majority of waste is burned before burial and the site is relatively dry, the actual quantity of methane gas generated will only be a fraction of the estimate.

Since waste is deposited above grade, the majority of methane gas migration is suspected to occur by direct venting into the atmosphere.

3.3.3 WATER QUALITY

Water quality analysis of the pond located adjacent to the site indicates possible contamination by runoff. Chemical analysis shows parameters of high concentrations of sulphate, chloride, bicarbonate, manganese and sodium (see Table 3.1).

3.3.4 CONCLUSION

The chemical analysis shows that the water in the pond adjacent to the site is of poor quality. Elevated levels of sulphate, chloride and bicarbonate indicate that leachate contamination from the disposal site may be occurring. The site location and geology suggest that the contamination could occur by runoff and near surface seepage of leachates from the site.

Subsurface and aquifer contamination from this site is not likely. The low permeability of the underlying sediments should confine leachates to surface and near surface environment. Consequently, contamination of well waters in this area is not likely.

3.3.5 RECOMMENDATIONS

a) Resampling of the adjacent surface waters should be undertaken.

b) A berm should be constructed around the site to limit leachate migration into the pond.

c) Burning of chemical containers should be avoided.

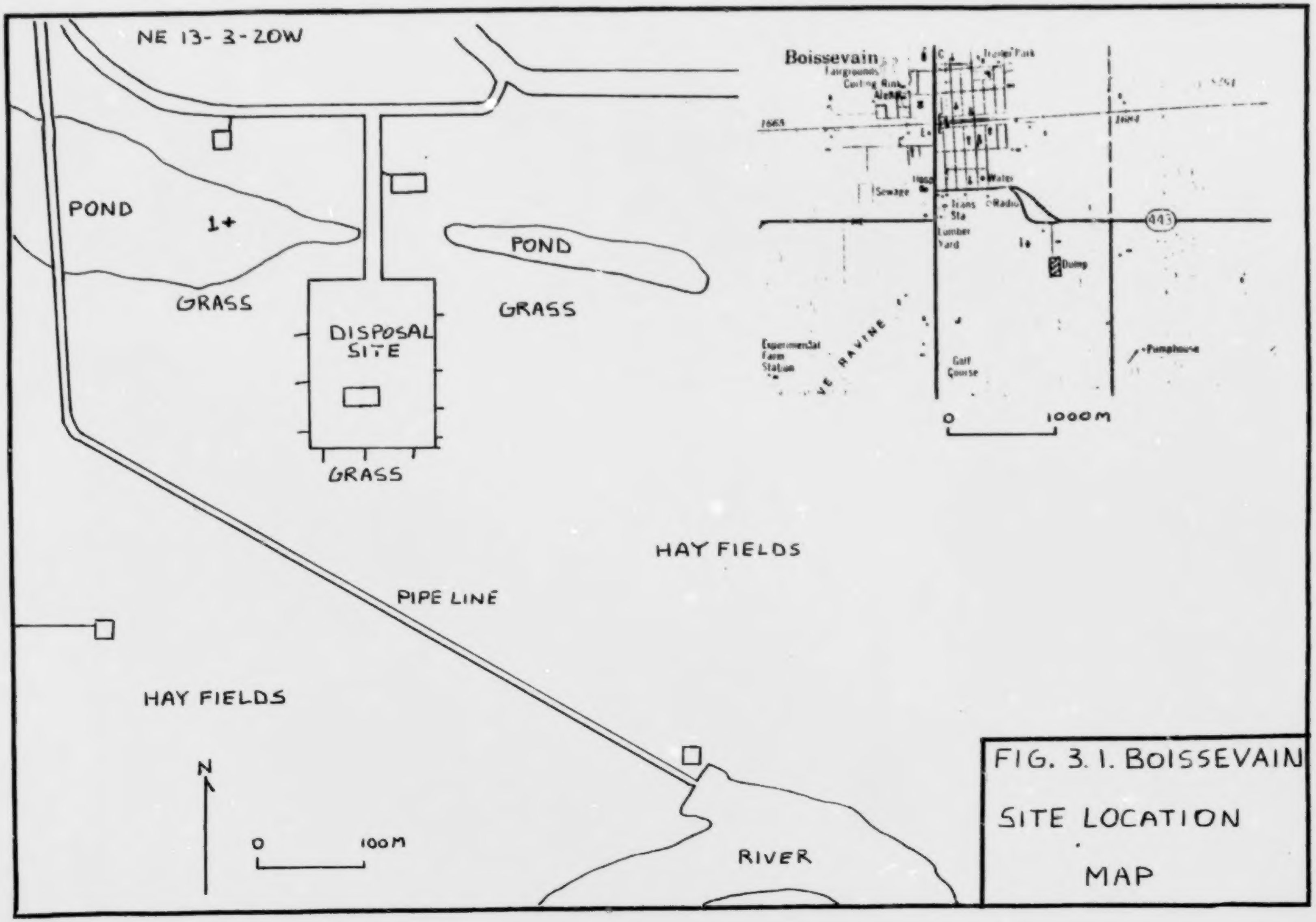

NE 13- 3-20W
POND
1+
GRASS
DISPOSAL SITE
GRASS
POND
GRASS
HAY FIELDS
PIPE LINE
HAY FIELDS
RIVER
N
0
100M
Boissevain
Fairgrounds
Curling Rink
Trailer Park
1665
1664
Water
Sewage
Trans Sta
Radio
Lumber Yard
Dump
443
Experimental Farm Station
RAVINE
Golf Course
Pumphouse
0
1000M

FIG. 3.1. BOISSEVAIN SITE LOCATION MAP

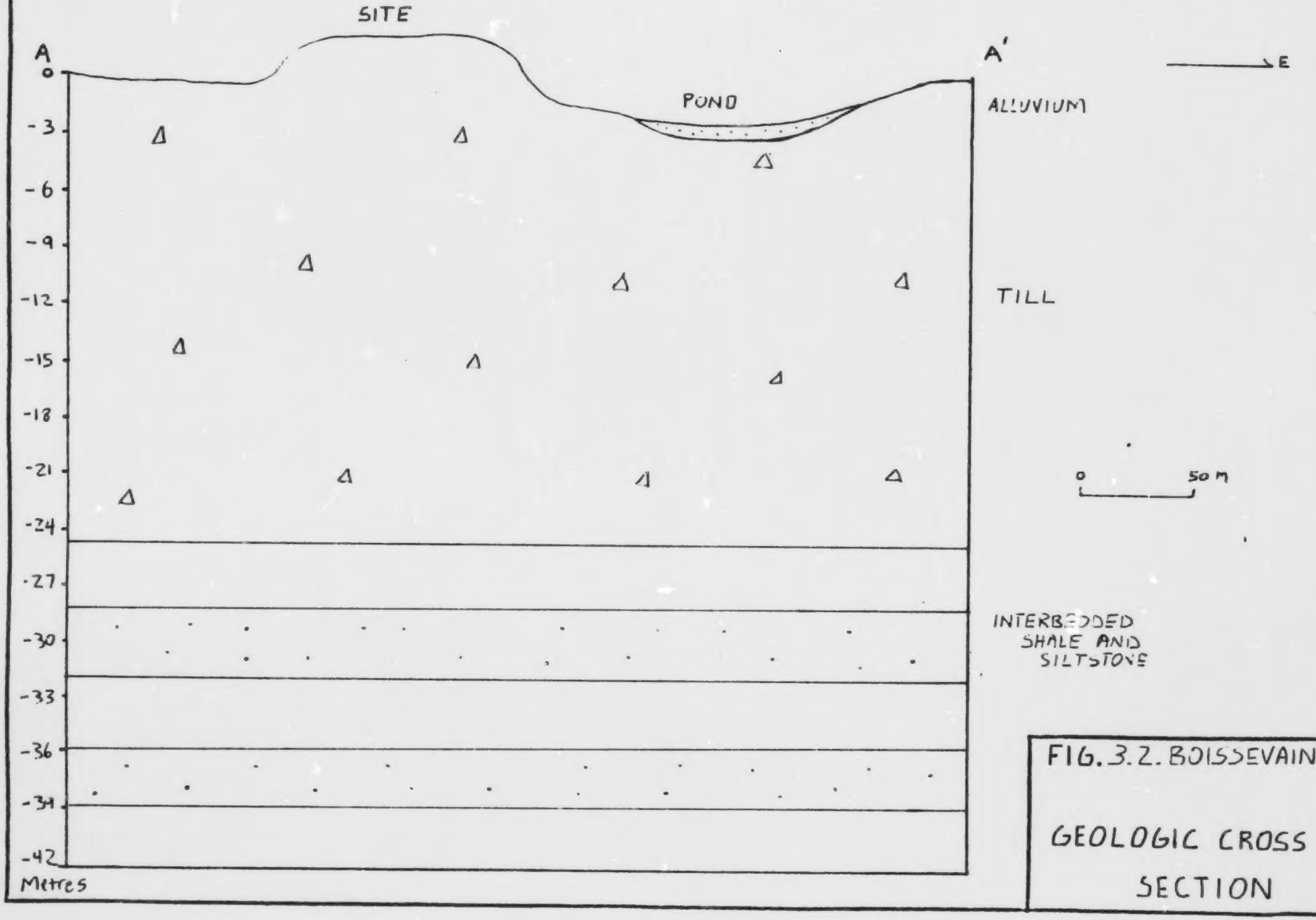

SITE
A
A'
E
POND
ALLUVIUM
TILL
0
50 m
INTERBEDDED SHALE AND SILTSTONE
0
-3
-6
-9
-12
-15
-18
-21
-24
-27
-30
-33
-36
-39
-42
Metres

FIG. 3.2. BOISSEVAIN

GEOLOGIC CROSS SECTION

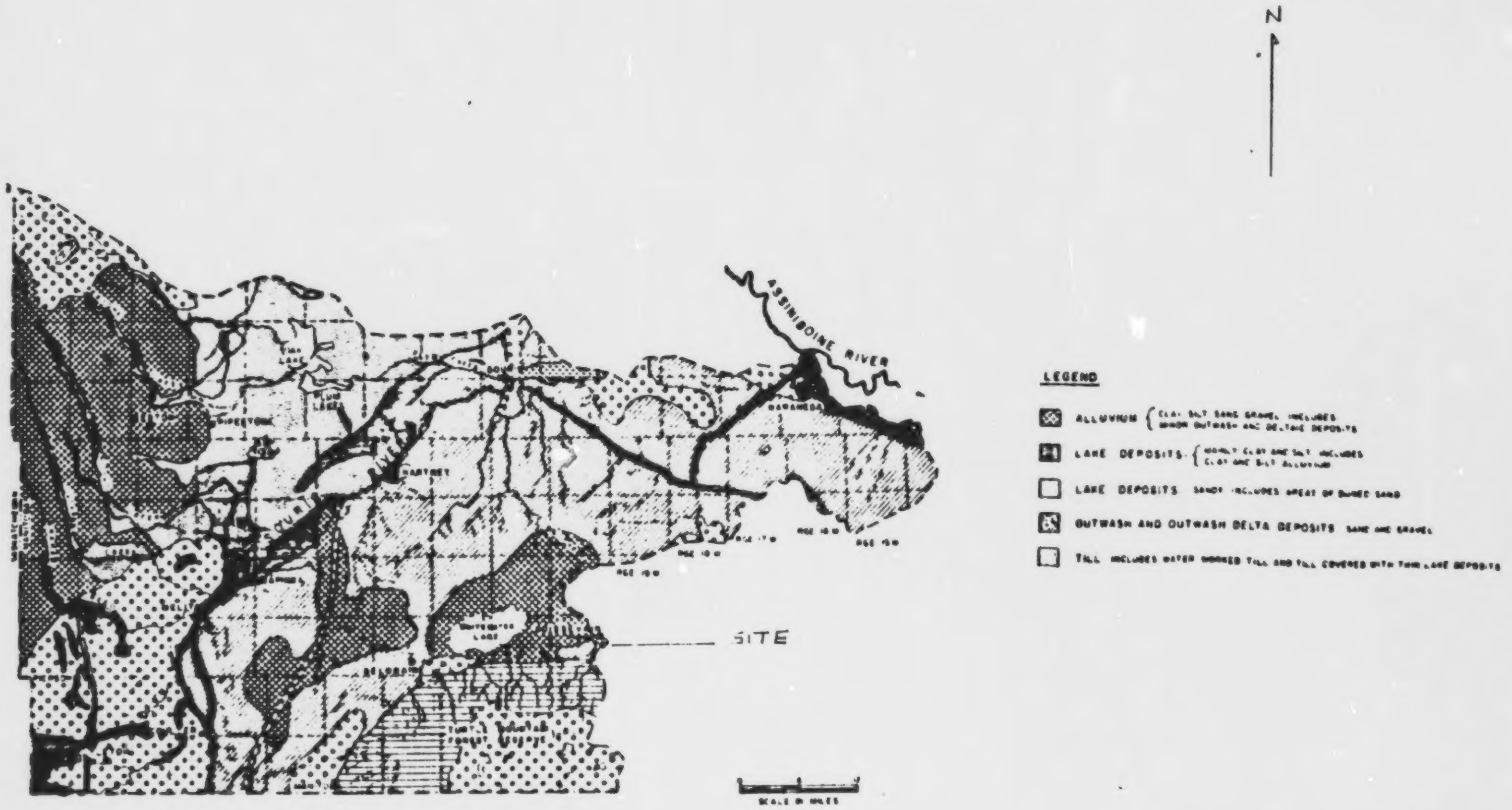

N
ASSINIBOINE RIVER
SITE
SCALE IN MILES
LEGEND
ALLUVIUM {CLAY SILT SAND GRAVEL INCLUDES MINOR OUTWASH AND DELTAIC DEPOSITS
LAKE DEPOSITS {MOSTLY CLAY AND SILT INCLUDES CLAY AND SILT ALLUVIUM
LAKE DEPOSITS SANDY INCLUDES AREAS OF DUNE SAND
OUTWASH AND OUTWASH DELTA DEPOSITS SAND AND GRAVEL
TILL INCLUDES WATER WORKED TILL AND TILL COVERED WITH THIN LAKE DEPOSITS

FIG. 3.3. BOISSEVAIN SURFICIAL DEPOSITS MAP

TABLE 3.1. BOISSEVAIN

Site Number	1			
Parameters				
Conductivity umho/cm	8210			
Residue Total mg/L	7920			
Residue Filt mg/L	6750			
Residue Non-Filt mg/L	1180			
pH units	8.35			
Alkal. Total ($CaCO_3$) mg/L	2540			
Alkalinity (HCO_3) mg/L	3060			
Alkalinity (CO_3) mg/L	21.6			
Alkalinity (OH) mg/L	0			
As (Ext.) mg/L	.038			
Cd (Ext.) mg/L	<.001			
Cu (Ext.) mg/L	.04			
Pb (Ext.) mg/L	.006			
Ni (Ext.) mg/L	.009			
Zn (Ext.) mg/L	.06			
Cr (Total) mg/L	.033			
Calcium (Ext.) mg/L	140			
Magnesium (Ext.) mg/L	237			
Hardness ($CaCO_3$) mg/L	1320			
Manganese (Ext.) mg/L	.84			
Iron (Ext.) mg/L	1.56			
Potassium (Ext.) mg/L	75.			
Sodium (Ext.) mg/L	2190			
COD mg/L	650			
T.O.C. mg/L	240			
Turbidity NTU	125			
CN (Free) mg/L	<.02			
Kjeldnal, Total-N mg/L	19.5			
NH_3-N (Sol.) mg/L	2.0			
NO_3-NO_2-N (Diss.) mg/L	.59			
P-Total mg/L	4.9			
Chloride (Sol.) mg/L	120			
Sulphate (Sol.) mg/L	2600			
Fecal Coliform /100 mL	-			
Total Coliform /100 mL	-			

CHAPTER - FOUR -

CARBERRY

R.M. OF NORTH CYPRESS

SE 35-10-15W

4 CARBERRY WASTE DISPOSAL SITE

4.1 RECONNAISSANCE DATA

4.1.1 LOCATION

The Town of Carberry, Manitoba, is located within the R.M. of North Cypress approximately 140 kilometres west of Winnipeg along P.R. 351 and P.T.H. 5. The waste disposal site is located about 1.6 kilometres west and 700 metres north of the town on Section SE 35-10-15W (see Figure 4.1).

4.1.2 PHYSIOGRAPHY

The area is located on the lightly rolling sand flats of the ancient Assiniboine Delta which connects the Southwestern Uplands with the Manitoba Lowlands. The area features little relief with remnants of sand encroached channel depressions and some ancient dune formations. Dip of the topography is easterly at a slight rate of 2 metres per kilometre.

The disposal site is located at the edge of the sand flats, bordered to the north by the ancient channel depression and to the south by a sand borrow pit dug into an ancient sand dune.

The depression is approximately 3 to 4 metres lower than the surrounding sand flats and disposal terrace. Vegetation ranges from willows in the depressed area northeast of the site to pine and oak along the ancient banks, and grassland to the west.

4.1.3 BACKGROUND

This waste disposal site has been operating in its present location for over 15 years. In 1977, the site was registered with the

Province as an existing waste disposal site. Present records indicated that this site serves approximately 1300 people. Primarily municipal waste from the Town of Carberry and household waste from the surrounding rural areas are deposited at this site. An open dumping system is used for the disposal of the household, agricultural and liquid wastes.

Water supplies consists of private wells set into the shallow sand aquifer. A major utilization of well water is located 850 m southwest of the site, at a cattle feedlot.

4.1.4 SITE CONDITIONS

A number of observations were made during a site inspection on September 12, 1984. Access to the site is north from P.R. 351 on a Section Road which terminates on the disposal terrace.

The terrace forms an active area of about 10 by 90 metres. Waste is deposited along the north embankment, burned, pushed over the edge and covered with sandy fill. The fill appears to be excavated at the base of the embankment and in the borrow pit south of the site.

Burning rubber tires and evidence of liquid sewage at the base of the embankment were noted. Agricultural chemical containers could be seen throughout the area. No buildings are located within approximately 600 m of the site. Overall, the site location and condition is fair.

4.1.5 DRILLING AND SAMPLING

Three monitoring wells were installed around the site on November 14 and 23, 1984. The wells are located on the site map (Figure 4.1) and soil logs summarized in Table 4.2.

Water samples from all three wells were taken on January 3, 1985 and submitted for analysis. The results are discussed in Section 4.3.3 and summarized in Table 4.1.

4.2 GEOLOGIC DATA

4.2.1 GEOLOGIC SETTING

The area is located in the central part of the proglacial Assiniboine Delta. Aeolian sand flats, formed by wind action on the deltaic sands after the last ice age, form the surficial deposit. A thick deposit of delta sand, silt and clay underlies the sand flats. Dense till with possible lenses of sand and gravel separate this deposit from bedrock (see Figure 4.2).

4.2.2 BEDROCK

The bedrock underlying this area consists primarily of shales from the Cretaceous Period. These shales are commonly calcareous, dark grey to black, and belong to the Faval Formation. The eroded bedrock surface has been logged at about 139 metres depth in this area.

4.2.3 OVERBURDEN

A total of approximately 139 metres of overburden cover the underlying bedrock. About 60 metres of glacial till forms the lower sediment unit. Lenses of sand and gravel may be included in this dense, calcareous clay till.

The overlying delta unit consists of about 75 metres of grey clays, silts and sands. The upper part of this unit features primarily sand, while silty clays dominate at depth. A 3-6 metre unit of clean aeolian sand forms the surficial unit in this area (see Figure 4.3).

4.2.4 GEOHYDROLOGY

Water tables in the area are 2.5-5.0 metres below grade. The groundwater generally flows in an easterly direction. Because this is a recharge area, a strong downward gradient is suspected, also.

The clean surficial sand unit and the underlying deltaic deposits form a very thick unconfined aquifer. Silts and clays, and the underlying till unit progressively confine the aquifer with depth.

4.3 ENVIRONMENTAL INTERPRETATION AND ASSESSMENT

4.3.1 LEACHATE HYDROLOGY

Two sources for leachate production exist on the site; the buried waste in the disposal terrace, and the sewage disposed in the northeast corner of the site.

Under normal conditions, the base of the dump terrace is located 2-3 metres above the water table but consecutive wet seasons may bring the waste in direct contact with the aquifer, increasing leachate production.

Sewage disposal on the site infiltrates directly through the clean surficial sand into the aquifer. A small leachate plume is assumed to develop with every slug of sewage disposed.

Upon contact with the groundwater, contaminants likely migrate eastwards with the groundwater flow. Wells within several hundred metres of the site may be affected.

4.3.2 METHANE

Based on the quantity of waste deposited at this site, an estimated 6 million cubic metres of methane gas may be generated per year. Since the majority of waste is burned before burial, the actual quantity of methane gas produced will only be a fraction of the estimate.

Migration of methane gas should be less than 50 metres at this site based on the permeability of the sediments.

4.3.3 WATER QUALITY

Chemical analysis of the three water samples taken from the monitoring wells located at the waste disposal site show varying levels of contamination (see Table 4.1). The sample from monitoring well 1 indicates possible contamination; sulphate, chloride, COD, T.O.C. manganese, lead and arsenic levels are higher than background quality. Some of the above parameters are found in concentrations above objective levels.

The sample from monitoring well 2 also indicates possible contamination; the arsenic, lead, nickel, zinc, chromium, manganese, iron and COD levels are higher then background quality and are the highest concentrations of all three samples. Some of the above parameters occur in concentrations above the maximum acceptable levels.

The sample from monitoring well 3 shows arsenic, lead, nickel, chromium, manganese, and iron levels are all higher than background quality and in concentrations higher than objective levels.

4.3.4 CONCLUSION

The disposal site is located on an unconfined aquifer, thus the area is pollution sensitive. Results from water samples taken from the monitoring wells show elevated levels of contaminants. Groundwater contamination by the site is suspected.

To date, the extent of the aquifer area affected is not known but dilution, dispersion and attenuation should decrease contaminant concentrations with distance from the site. Several drinking water wells are located within 1000 metres from the disposal site and the nearest about 650 metres.

4.3.5 RECOMMENDATIONS

a) Sampling of wells within 1 kilometre of the site is recommended.

b) Resampling of the monitoring wells around the site is desirable.

c) Disposal of sewage at this site should be discontinued since no proper retention facility exists.

d) Agricultural chemical containers should be confined to a designated area on the site for collection.

f) Rubber tires should not be burned.

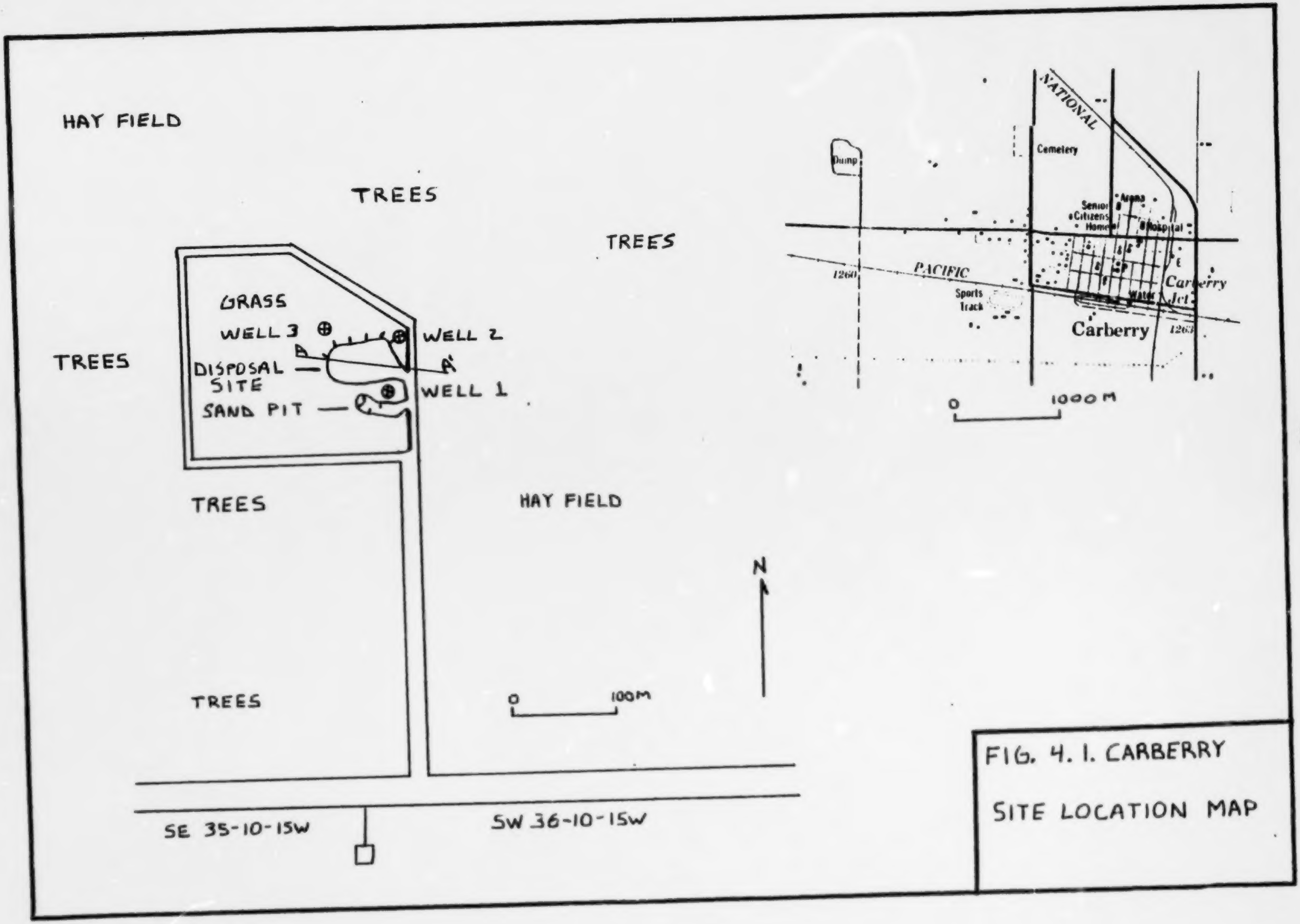

HAY FIELD
TREES
TREES
TREES
GRASS
WELL 3
WELL 2
A
A'
DISPOSAL SITE
WELL 1
SAND PIT
TREES
HAY FIELD
TREES
0
100M
N
SE 35-10-15W
SW 36-10-15W
Dump
Cemetery
NATIONAL
Senior Citizens Home
Arena
Hospital
PACIFIC
1260
Sports Track
Water
Carberry
Carberry Jct.
1263
0
1000 M

FIG. 4. 1. CARBERRY

SITE LOCATION MAP

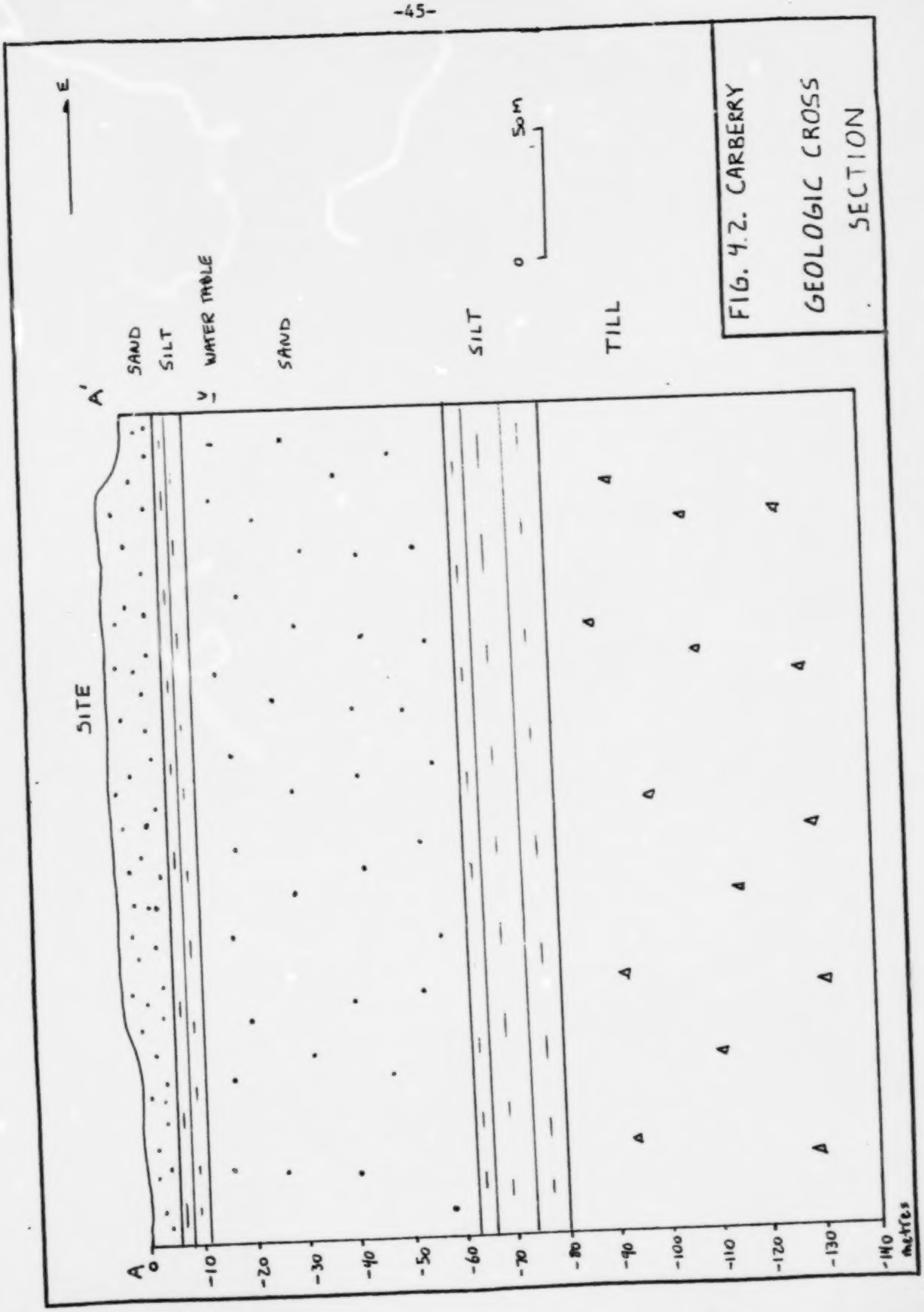

A
A'
SITE
E
0
50m
SAND
SILT
WATER TABLE
SAND
SILT
TILL
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
metres

FIG. 4.2. CARBERRY GEOLOGIC CROSS SECTION

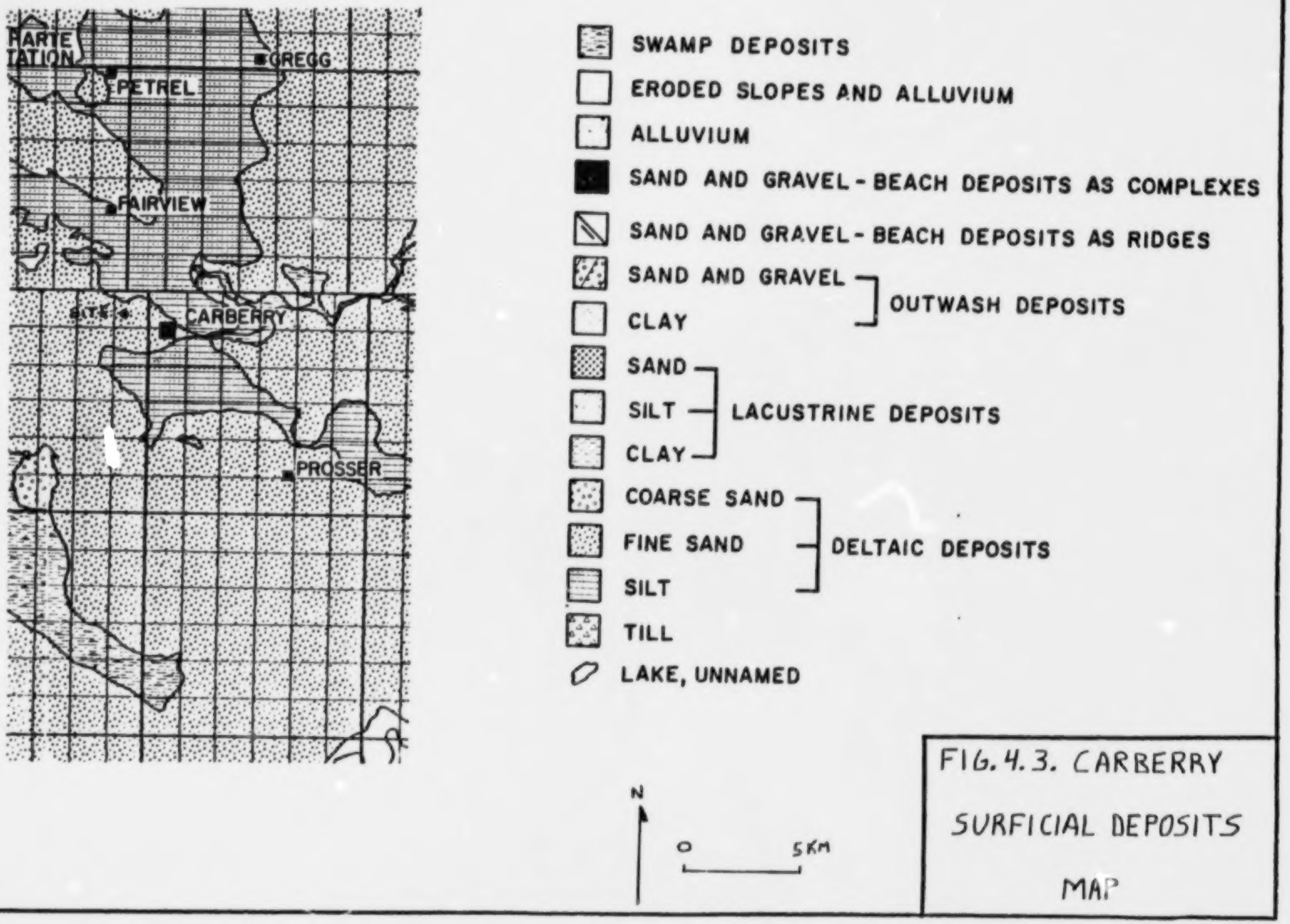

HARTE
TATION
PETREL
GREGG
FAIRVIEW
SITE
CARBERRY
PROSSER
SWAMP DEPOSITS
ERODED SLOPES AND ALLUVIUM
ALLUVIUM
SAND AND GRAVEL - BEACH DEPOSITS AS COMPLEXES
SAND AND GRAVEL - BEACH DEPOSITS AS RIDGES
SAND AND GRAVEL
CLAY
OUTWASH DEPOSITS
SAND
SILT
CLAY
LACUSTRINE DEPOSITS
COARSE SAND
FINE SAND
SILT
DELTAIC DEPOSITS
TILL
LAKE, UNNAMED
N
0
5KM

FIG. 4.3. CARBERRY SURFICIAL DEPOSITS MAP

TABLE 1.1. CARBERRY

Site Number	1	2	3	
Parameters				
Conductivity umho/cm	935	567	500	
Residue Total mg/L	650	2150	320	
Residue Filt mg/L	610	450	290	
Residue Non-Filt mg/L	44	1700	28	
pH units	7.70	7.40	7.65	
Alkal. Total ($CaCO_3$) mg/L	312.	366.	266	
Alkalinity (HCO_3) mg/L	381.	447.	325	
Alkalinity (CO_3) mg/L	0	0	0	
Alkalinity (OH) mg/L	0	0	0	
As (Ext.) mg/L	.003	.021	.016	
Cd (Ext.) mg/L	<.001	<.001	<.001	
Cu (Ext.) mg/L	<.01	.03	.06	
Pb (Ext.) mg/L	.040	.017	.051	
Ni (Ext.) mg/L	<.005	.015	.042	
Zn (Ext.) mg/L	.03	.13	.05	
Cr (Total) mg/L	.005	.033	.023	
Calcium (Ext.) mg/L	139	127.	128	
Magnesium (Ext.) mg/L	39.3	40.1	32.0	
Hardness ($CaCO_3$) mg/L	509	482	452	
Manganese (Ext.) mg/L	.38	.89	1.40	
Iron (Ext.) mg/L	.81	10.2	10.	
Potassium (Ext.) mg/L	<5.0	<5.0	<5.0	
Sodium (Ext.) mg/L	21.0	9.60	4.36	
COD mg/L	260	120	67	
T.O.C. mg/L	112	34.	35.5	
Turbidity NTU	8.	500	20.	
CN (Free) mg/L	<.02	<.02	<.02	
Kjeldnal, Total-N mg/L	18.0	4.0	4.3	
NH_3-N (Sol.) mg/L	.03	.22	.15	
NO_3-NO_2-N (Diss.) mg/L	.06	.03	.01	
P-Total mg/L	.05	.98	.22	
Chloride (Sol.) mg/L	65	3.0	3.0	
Sulphate (Sol.) mg/L	105	14.4	18.8	
Fecal Coliform /100 mL	-	-	-	
Total Coliform /100 mL	-	-	-	

TABLE 4.2 CARBERRY SOIL LOGS

WELL #	DEPTH (METRES)	DESCRIPTION
1	0 - 3	fine to med. sand
	3 - 8	med. sand (yellow)
	8 - 15	med. sand (grey)
2	0 - 6.7	fine to med. sand (yellow)
	6.7 - 26	med. sand (grey)
	26 - 32	very soft clay
3	0 - 6.7	fine to med sand (yellow)
	6.7 16	med. sand (yellow)
	16 - 26	med. sand (grey)

CHAPTER - FIVE -

CRYSTAL CITY

R.M. OF LOUISE

SW-25-2-12W

5 CRYSTAL CITY WASTE DISPOSAL SITE

5.1 RECONNAISSANCE DATA

5.1.1 LOCATION

The Town of Crystal City, Manitoba, is located within the R.M. of Louise, approximately 131 Km southwest of Winnipeg along P.T.H. 3 and 34. The waste disposal site is located about 750 metres southwest of the town on Section SW 25-2-12W, (see Figure 5.1).

5.1.2 PHYSIOGRAPHY

The area is located on the Southwestern Uplands of Manitoba. This region is characterized by rolling till landscapes, glacial spillways and ice marginal outwash areas. The site is located on such an ice marginal area.

The area consists of flat open silt plains with essentially no relief. Crystal Creek is incised 3 to 4 metres below grade of the open prairie. Vegetation consists primarily of agricultural fields with localized tree growth along the river banks.

The absence of sloughs and ponds in the area suggest absorption of precipitation into the ground. Further, the lack of gullies and drainage ditches suggest a moderately adhesive and semipermeable soil conditions in the area.

5.1.3 BACKGROUND

The waste disposal site has been operating on this location for over 15 years. Historically, refuse seems to have been buried closer to the road as evident by a large mound located west of the active area. The mound is overgrown with vegetation.

In 1977, the site was registered with the Province as an existing waste disposal site. Present records show that this site serves approximately 500 people. Primarily municipal waste from Crystal City and household waste from the surrounding rural areas are deposited at this site. A trench system is now used to dispose of household and agricultural and some bulky metallic waste and tires.

Water supply in this region is derived from privately owned wells set into the bedrock aquifer. A two cell sewage lagoon which serves the town, discharges into Crystal Creek 400 m north of the disposal site.

5.1.4 SITE CONDITIONS

During the site inspection on September 13, 1984, several observations were made. The site is located directly off a Section Road approximately 1 Km southwest of town, and covers an area of about 150 m by 60 m. The active area consists of a trench, 40 m by 2 m by 2 m, a small agricultural chemical container compound, and an open disposal pile of construction and metallic wastes.

The waste disposal method consists of dumping into a trench, followed by burning and fill cover twice per year. All types of wastes were observed in this trench including large metallic wastes and tires.

Overall the site is in fair condition and moderately well kept. Access to the site is adequate year round and the nearest building is over 900 metres away. However, only one side of the area is fenced and some debris was seen strewn on the adjacent field.

5.2 GEOLOGIC DATA

5.2.1 GEOLOGIC SETTING

The area is located on clayey, ice marginal silts. These silts form an even, thin veneer covering the underlying shale bedrock. The upper part of the shale unit is usually strongly weathered and partially intermixed with silt. With depth, the shale becomes hard, fractured and saturated (see Figure 5.2).

5.2.2 BEDROCK

The bedrock underlying this area consists of hard fractured shales from the Cretaceous Period. The shale beneath the site is refered to as the Odanah Member of the Riding Mountain Formation. It is commonly dark grey to green grey, brittle and fractured.

The weathered bedrock surface is at an elevation of 454 metres; only 3 - 4 metres below grade. At a depth of about 100 metres, fractured shale is underlain by soft, firm Millwood Shale.

5.2.3 OVERBURDEN

Approximately 3 - 4 metres of overburden cover the weathered bedrock surface. A black clayey silt loam topsoil overlies a clayey silt unit with a high percentage of weathered shale (see Figure 5.3). The plasticity of this unit is low and decreases with increasing shale content and depth.

5.2.4 GEOHYDROLOGY

The water table beneath the site is estimated at approximately 2 - 4 metres below grade. The associated hydraulic gradient is northeast towards Crystal Creek.

The weathered and fractured shale serves as the main aquifer in this area. The total bedrock aquifer thickness is about 100 metres, with the lower confining unit formed by firm Millwood Shale. However, wells reported in the area only draw water from 23 to 37 metres depth.

Local recharge of the aquifer occurs primarily by inflow from surrounding areas and partially by infiltration of precipitation through the semipermeable overburden.

5.3 ENVIRONMENTAL INTERPRETATION AND ASSESSMENT

5.3.1 LEACHATE HYDROLOGY

The new and buried waste serves as a source for leachate production on the site. The waste is located above the water table, limiting leachate infiltration to intermittent precipitation.

The clayey silt unit underlying the site forms a 3 - 4 metre semipermeable confining unit. The rate of infiltration into the aquifer is thus reduced by the low permeability and moisture storing capacity of this unit. As a result, downward migration of contaminants is slow and intermittent.

The extent of leachate migration is unknown, but due to the absence of wells between Crystal Creek and the site, drinking water in the area should not be affected.

5.3.2 METHANE

Based on the amount of waste deposited, an estimated two million cubic metres of methane gas may be generated per year. However, since most of the waste is burned before burial, and the site is relatively dry, only a fraction of the estimate will be generated. The migration distance of any methane gas produced should be limited to a distance of 40 metres based on the permeability of the soil.

5.3.3 WATER QUALITY

The confining clayey silt layer above the bedrock aquifer has a good capacity to attenuate contaminants due to the high organic-clay content of the soil. Further, water quality of the aquifer is considered naturally poor due to high levels of chloride nitrate, sodium, potassium and dissolved solids.

5.3.4 CONCLUSION

Based on the data available to date, the environmental impact of this site and the potential for groundwater contamination of the underlying shale aquifer are low. Since the site serves a small population of 900 people, and a semiconfining silt underlies the site, and the natural water quality is poor, no noticeable effect on water quality is expected. Further, no wells are located between the site and Crystal Creek.

Methane generation from the buried waste is not of concern since the site is adequately removed from residences. Further, the quantity of methane gas produced is low because the site is relatively dry and wastes are burned before burial.

The location of the site is acceptable, but smoke drift into town may occur under southwest wind conditions. Overall the site is in fair condition.

5.3.5 RECOMMENDATIONS

a) Since the clayey silt unit is only 3 - 4 metres thick, trenching in this area may increase the pollution hazard. All waste should be buried above ground.

b) The existing fences should be extended around the site to minimize debris blowing off site limits.

c) A tree lined greenbelt around the site would reduce smoke drift and improve site esthetics.

d) Separate areas, with approriate signs, should be established for bulky metallic wastes.

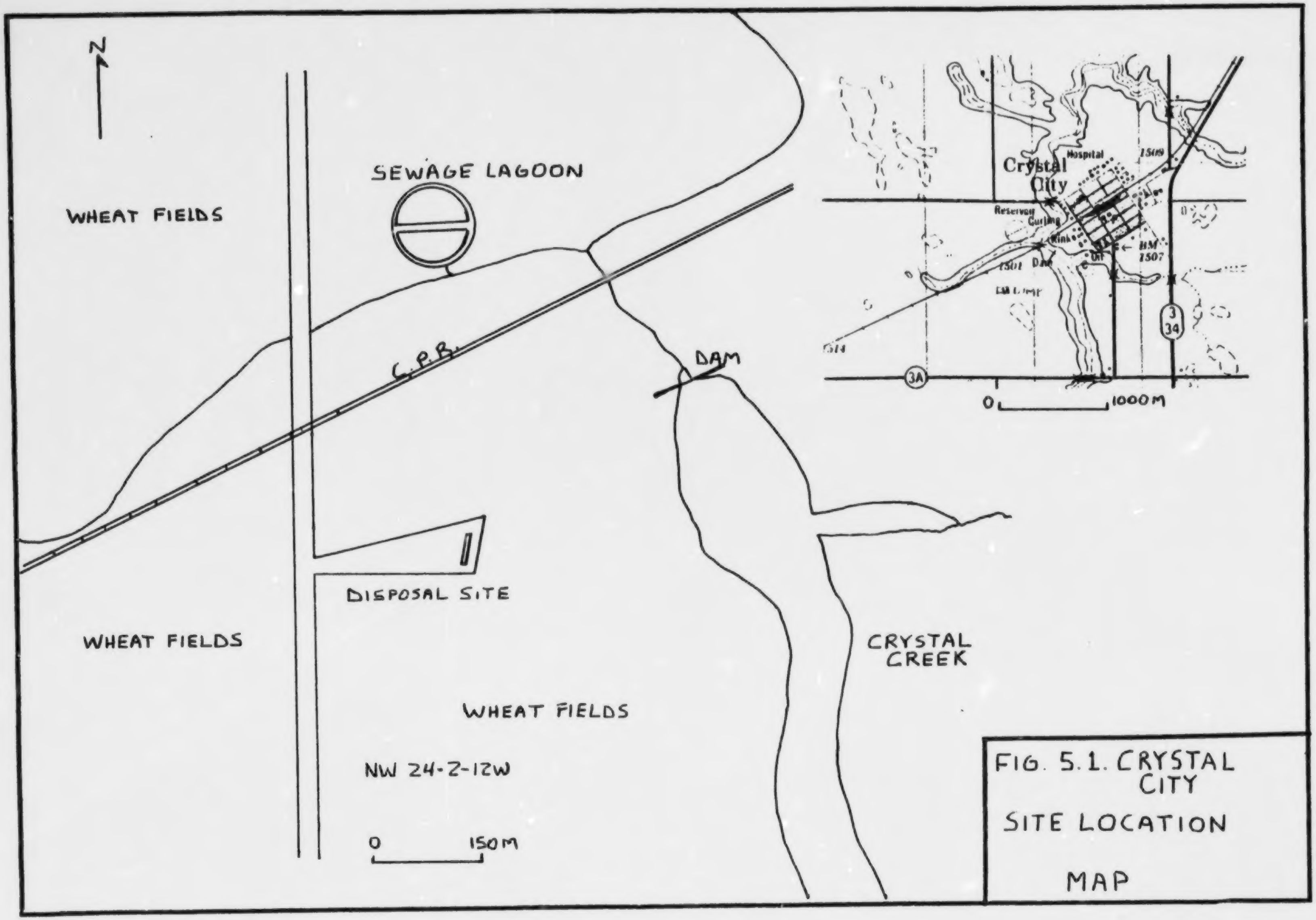

N
SEWAGE LAGOON
WHEAT FIELDS
C.P.R.
DAM
DISPOSAL SITE
WHEAT FIELDS
CRYSTAL CREEK
WHEAT FIELDS
NW 24-2-12W
0
150M
Crystal City
Hospital
1509
Reservoir
Curling Rinks
BM 1507
1501
Dam
3
34
3A
1514
0
1000M

FIG. 5.1. CRYSTAL CITY SITE LOCATION MAP

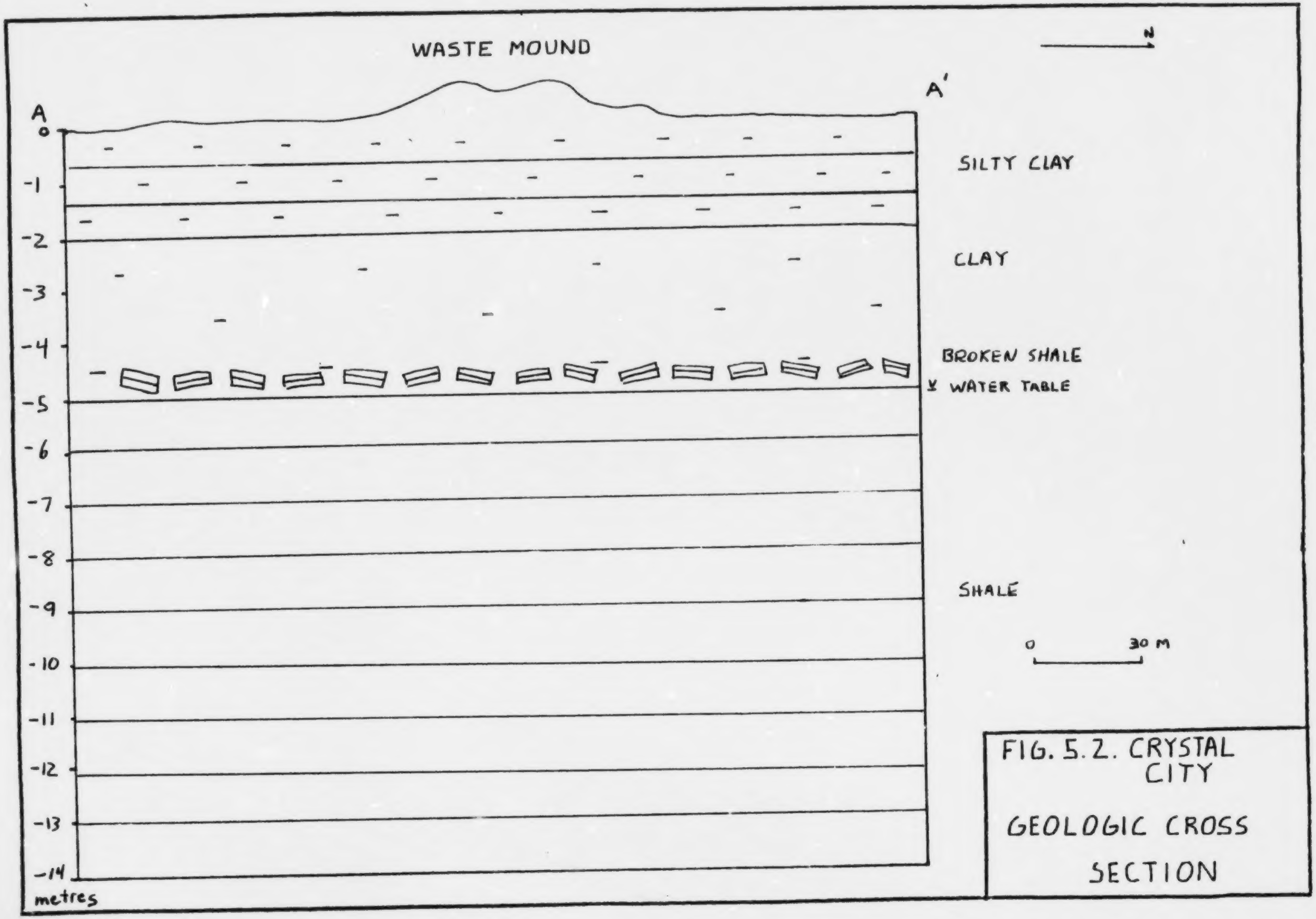

WASTE MOUND
N
A
A'
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
-11
-12
-13
-14
metres
SILTY CLAY
CLAY
BROKEN SHALE
WATER TABLE
SHALE
0
30 M

FIG. 5.2. CRYSTAL CITY

GEOLOGIC CROSS SECTION

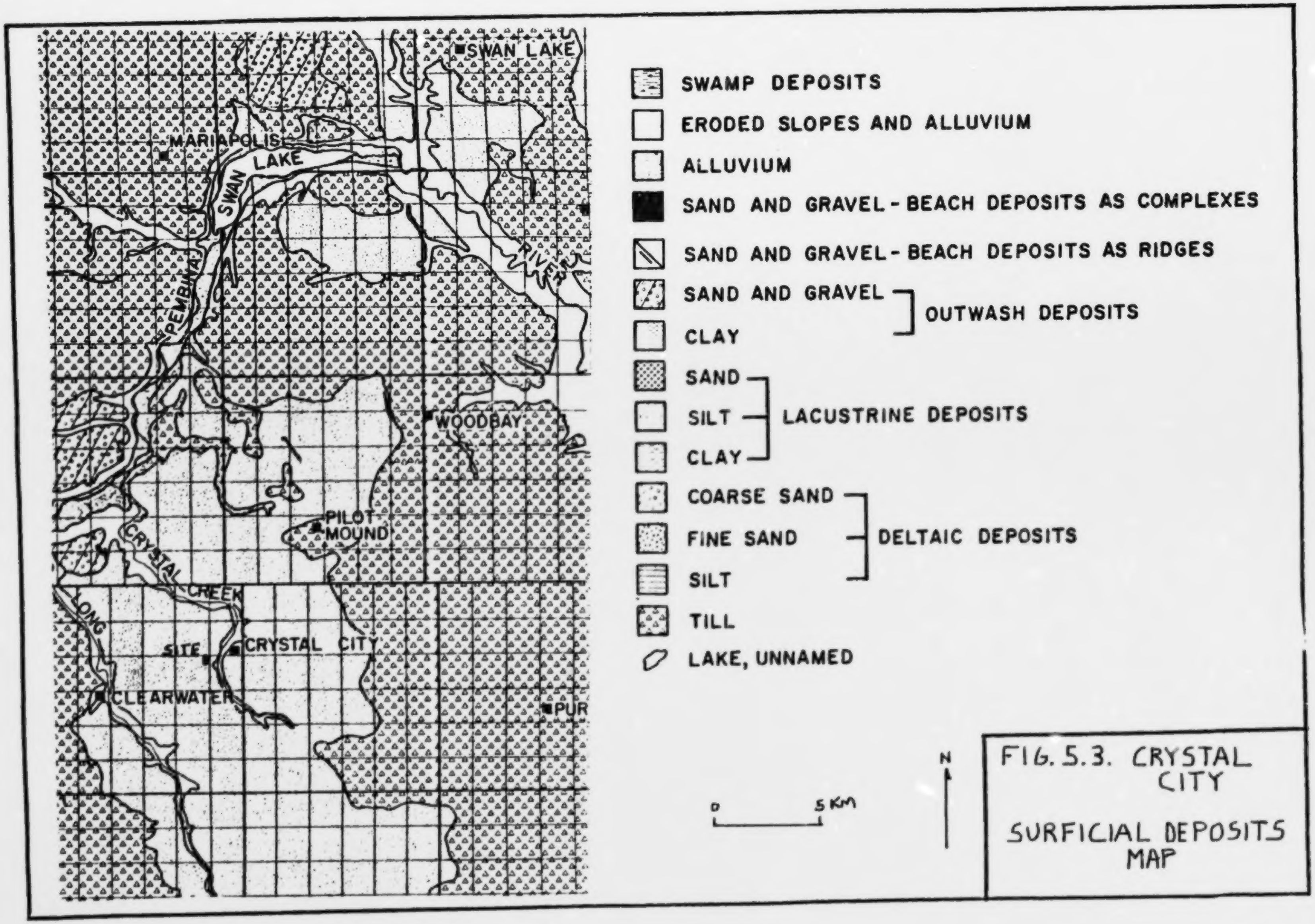

SWAN LAKE
MARIAPOLIS
SWAN LAKE
PEMBINA
RIVER
WOODBAY
PILOT MOUND
CRYSTAL CREEK
LONG
SITE
CRYSTAL CITY
CLEARWATER
PUR
SWAMP DEPOSITS
ERODED SLOPES AND ALLUVIUM
ALLUVIUM
SAND AND GRAVEL - BEACH DEPOSITS AS COMPLEXES
SAND AND GRAVEL - BEACH DEPOSITS AS RIDGES
SAND AND GRAVEL
CLAY
OUTWASH DEPOSITS
SAND
SILT
CLAY
LACUSTRINE DEPOSITS
COARSE SAND
FINE SAND
SILT
DELTAIC DEPOSITS
TILL
LAKE, UNNAMED
0
5 KM
N

FIG. 5.3. CRYSTAL CITY

SURFICIAL DEPOSITS MAP

CHAPTER - SIX -

DARLINGFORD

R.M. of Pembina

NW-7-3-7W

6 DARLINGFORD WASTE DISPOSAL SITE

6.1 RECONNAISSANCE DATA

6.1.1 LOCATION

The Town of Darlingford is located in the R.M. of Pembina, approximately 96 kilometres southwest of Winnipeg, off P.T.H. 3. The waste disposal site is located about 1250 metres west of the town on Section NW 7-3-7W, (See Figure 6.1).

6.1.2 PHYSIOGRAPHY

The site is located near the eastern edge of the Southwestern Uplands. The area consists of glacial end morraine flats with gently rolling till ridges. Surficial waters occur in the form of small sloughs, ponds and seasonal flow in creek channels. Regional drainage is down the eastern slope of this morraine, through deeply incised misfit stream beds, into the Manitoba Lowlands.

An open landscape of agricultural fields dominate the vegetation around the site. A slough pasture immediately south of the site supports heavy growth of grasses, shrubs and willows. No immediate drainage exists around the site.

6.1.3 BACKGROUND

This waste disposal site has been operating in this location for over 15 years. In 1977, the site was registered with the Province as an existing waste disposal ground. Present records show that this site serves approximately 500 people. Primarily municipal waste from the Town of Darlingford and household waste from the surrounding rural areas are deposited at this site. All wastes including bulky metallic, tires, and household and agricultural wastes are deposited above grade.

Public water supply is derived from wells, set into a confined gravel and sand aquifer. Rural residents derive groundwater from similar aquifers. The area is also served by a two cell sewage lagoon discharging east of the town, downstream of the site.

6.1.4 SITE CONDITIONS

During the site inspection on September 13, 1984, several observations were made. The site is located directly south of the Section Road 1.2 Km west of the town, and is approximately 50 m by 150 m. The active area consists of surficial disposal covering an area of 80 m by 5 m, and includes an agricultural chemical container compound. Waste is surficially dumped, burned, and covered by fill or more waste. The current burned waste fill mound is about 1.5 - 2.0 m above grade.

The entire site is fenced in, and signs are posted indicating disposal instructions. Agricultural chemical containers can be found in various locations other than the designated area. Overall the site is in fair condition with adequate year round access to the site. The location of the site is good because of the absence of buildings in the site area; the nearest dwelling being over 1 Km away.

6.1.5 DRILLING AND SAMPLING

A drilling program and sampling were not undertaken for the Darlingford site.

6.2 GEOLOGIC DATA

6.2.1 GEOLOGIC SETTING

The study area is located on the ancient till ridges of the Darlingford moraine which marked the edge of late glacial ice sheets approximtely 14,000 years ago. The clay till cover overlying the shale bedrock in this area is relatively thin; thus, regional topography strongly reflects the underlying bedrock relief (see Figures 6.2 and 6.3).

6.2.2 BEDROCK

The bedrock underlying the site consists of shales from the Cretaceous Period. This bedrock is part of the Odanah member of the Riding Mountain formation which features dark grey shales with highly fractured zones. These zones are saturated with groundwater and compose the bedrock aquifer in this area.

6.2.3 OVERBURDEN

Approximately 15 to 25 metres of highly calcareous clay till with frequent water bearing stringers and lenses of sand and gravel overlies bedrock. Beneath the site, the first 0.5 metre of till is soft, grey silty clay with low plasticity. As a result, surface infiltration in this area is possible without surface ponding.

6.2.4 GEOHYDROLOGY

Essentially, two types of aquifers exist in this area; fracture zones in the shale bedrock, and lenses of sand and gravel in the clayey till. Both aquifer types are confined by the overlying till unit.

Generally, recharge of the bedrock aquifer is independent of infiltration in this area. However, lenses of sand and gravel may be locally recharged by slow infiltration of precipitation through semipermeable passages in the till.

6.3 ENVIRONMENTAL INTERPRETATION AND ASSESSMENT

6.3.1 LEACHATE HYDROLOGY

This site is located on clayey till well above the groundwater table; thus, leachate generation is limited to the intermittent infiltration of precipitation. The downward migration of contaminants is further hindered by the high capacity for the retention of moisture in the till and overall low permeability.

The extent of leachate migration in the area is estimated to be confined to within 200 metres of the site. Contamination of wells in the area by this site is not likely.

6.3.2 METHANE

Based on the amount of waste deposited an estimated 2 million cubic metres per year of methane gas may be produced. Since the waste is burned before fill covering, and the waste is relatively dry, the actual quantity of methane gas generated will only be a fraction of the estimate. Migration of any gas methane produced should be limited because waste is deposited above grade. Methane gas generated will most likely vent into the atmosphere directly, with little subsurface migration.

6.3.3 WATER QUALITY

The water quality in this region is considered good for the bedrock and gravel lense aquifers. Water quality should not be affected by the site since leachates are not expected to contaminate the aquifers and the capacity of the sediments to attenuate cations is good.

6.3.4 CONCLUSION

Based on the available data, the environmental impact of this site is very low. The site has no predicable effect on the bedrock aquifer because of the clayey till overburden. No wells are located closer than one kilometre from the site; beyond any effect the site might have on the shallow sand and gravel aquifers. No vegetation strain was observed in the adjacent slough vegetation. Methane generation from the burnt waste is suspected to be low and not considered a problem.

The general location of this site poses some problems. Because the site is located between the railway track and the road allowance, little site area is left after subtracting recommended clearances.

6.3.5 RECOMMENDATIONS

a) A separate area for the collection of bulky metallic wastes, designated with appropriate signs, should be established.

b) Since the site is located in an open area, tires should not be burned. The thick black smoke may drift for considerable distance and cause poor site esthetics and air pollution.

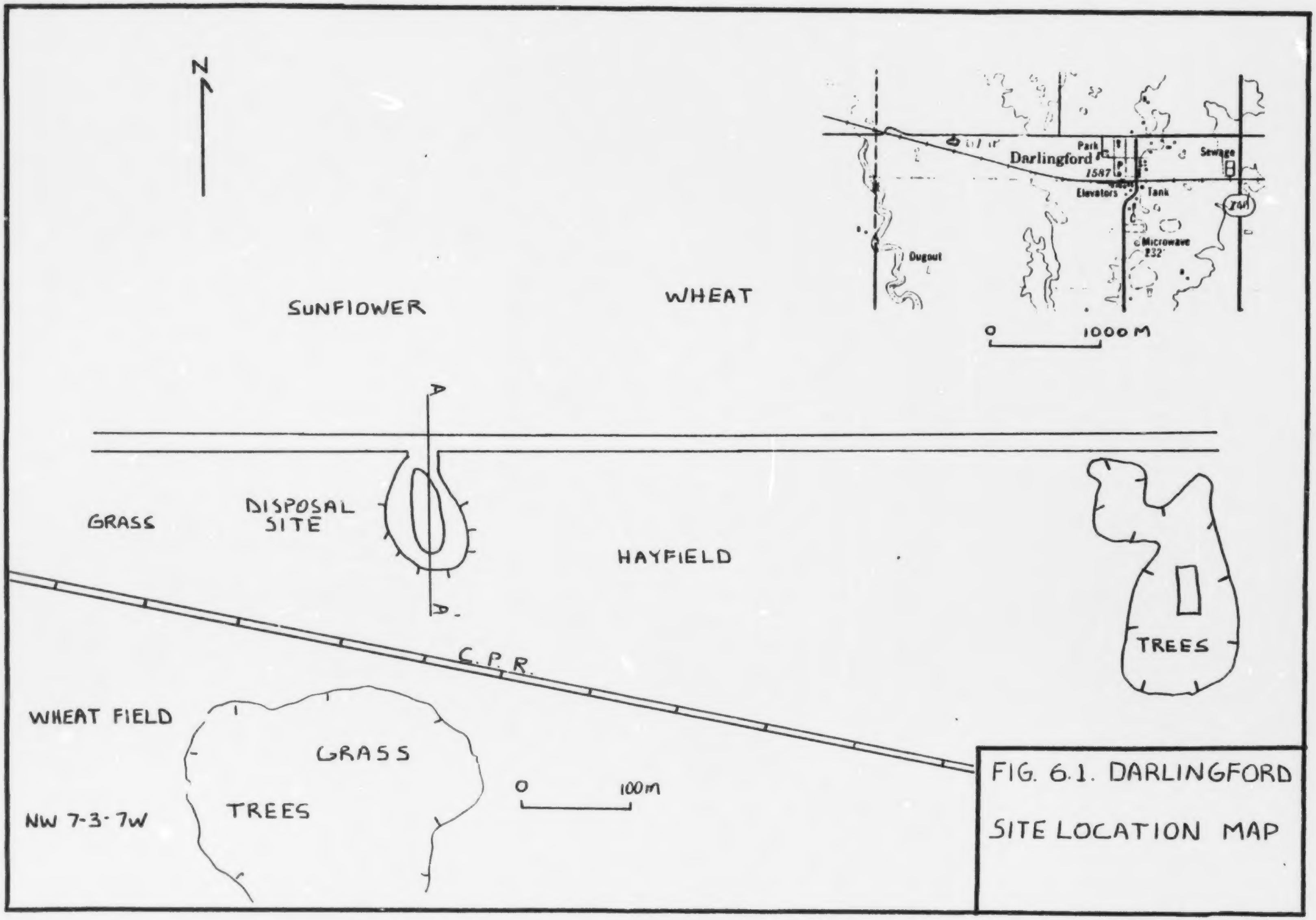

N
SUNFLOWER
WHEAT
Darlingford
Park
1587
Elevators
Tank
Sewage
Microwave
232
Dugout
0
1000 M
A
A'
GRASS
DISPOSAL
SITE
HAYFIELD
TREES
C.P.R.
WHEAT FIELD
GRASS
TREES
NW 7-3-7W
0
100m

FIG. 6.1. DARLINGFORD SITE LOCATION MAP

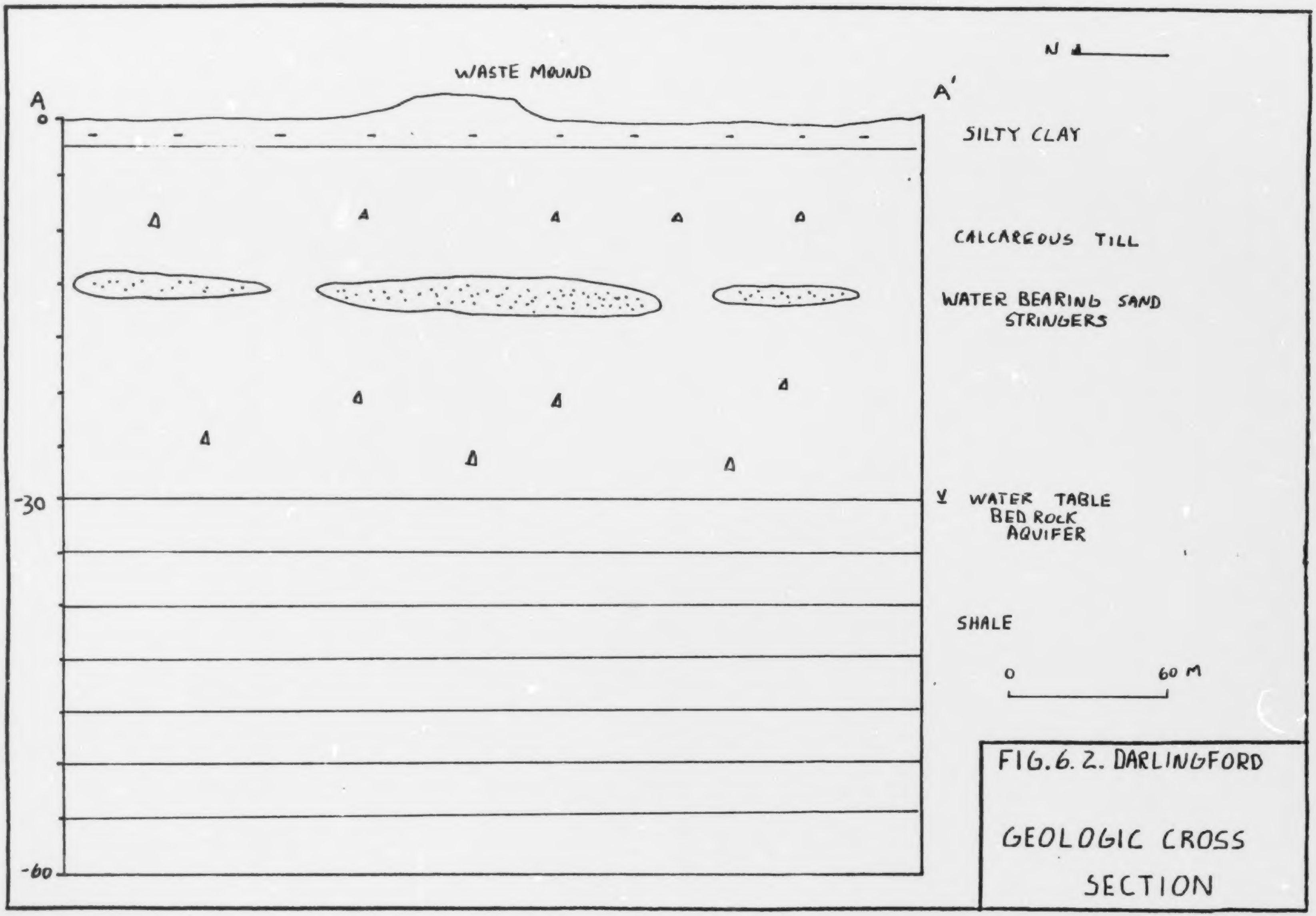

N
WASTE MOUND
A
A'
0
-30
-60
SILTY CLAY
CALCAREOUS TILL
WATER BEARING SAND STRINGERS
WATER TABLE
BED ROCK AQUIFER
SHALE
0
60 M

FIG. 6. 2. DARLINGFORD

GEOLOGIC CROSS SECTION

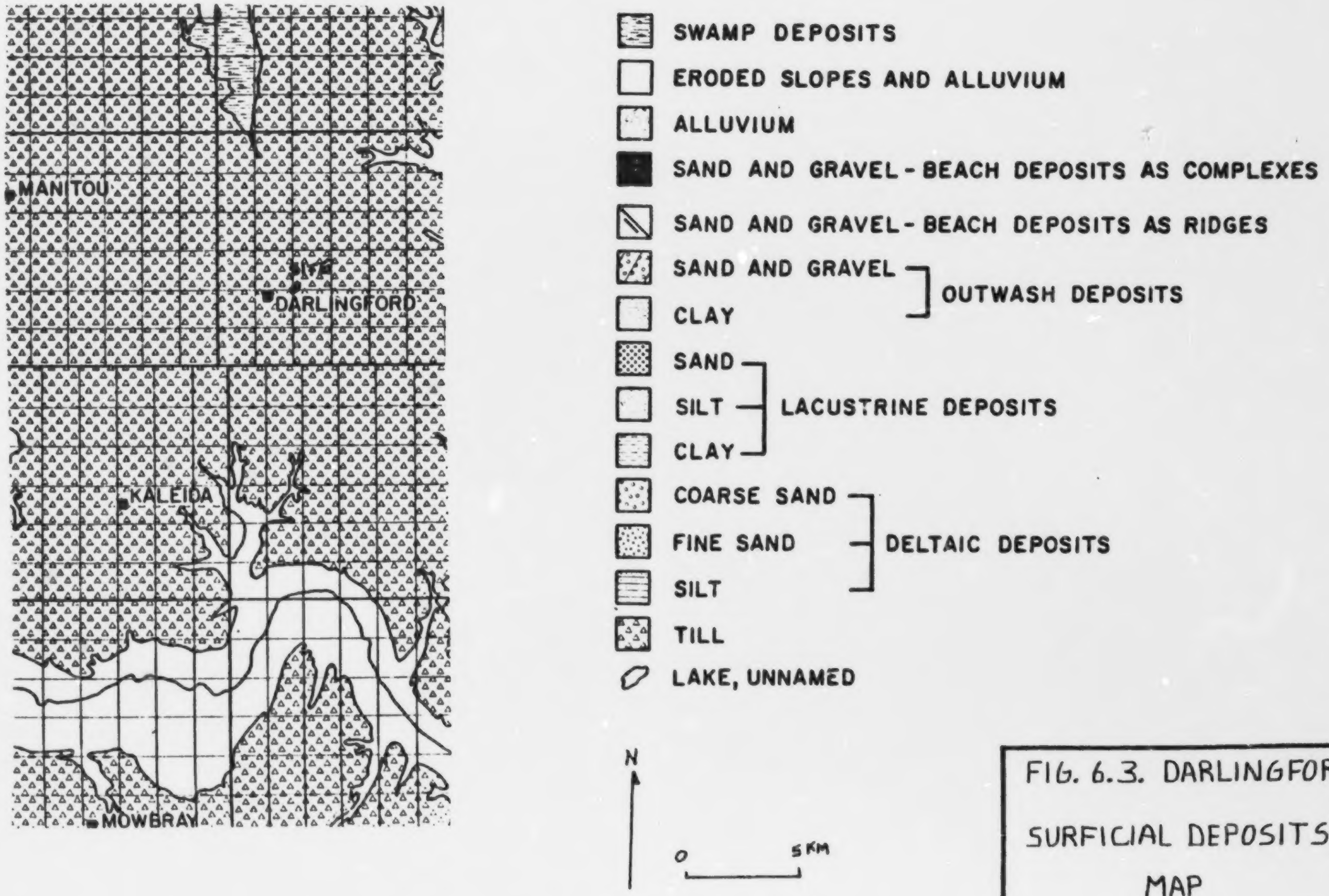

MANITOU
SITE
DARLINGFORD
KALEIDA
MOWBRAY
SWAMP DEPOSITS
ERODED SLOPES AND ALLUVIUM
ALLUVIUM
SAND AND GRAVEL - BEACH DEPOSITS AS COMPLEXES
SAND AND GRAVEL - BEACH DEPOSITS AS RIDGES
SAND AND GRAVEL
CLAY
OUTWASH DEPOSITS
SAND
SILT
CLAY
LACUSTRINE DEPOSITS
COARSE SAND
FINE SAND
SILT
DELTAIC DEPOSITS
TILL
LAKE, UNNAMED
N
0
5KM

FIG. 6.3. DARLINGFORD SURFICIAL DEPOSITS MAP

CHAPTER - SEVEN -

DELORAINE

R.M. of Winchester

SE-11-3-23W

7 DELORAINE WASTE DISPOSAL SITE

7.1 RECONNAISSANCE DATA

7.1.1 LOCATION

The Town of Deloraine, Manitoba, is located in the R.M of Winchester, and is approximately 214 Km west southwest of Winnipeg along P.T.H. 3. The waste disposal site is located approximately 1 Km northeast of the town on Section SE 11-3-23W. (Figure 7.1).

7.1.2 PHYSIOGRAPHY

The site is located on the plains of the Southwestern Uplands. The topography in the area consists of flat open prairie with no relief other than a shallow channel of Medora Creek, 350 metres west of the disposl site. Small depressions form sloughs, pastures and small swamps.

Vegetation consists of agricultural fields with small patches of grassed swamp depressions.

Surface drainage is into Medora Creek, flowing from south to north. A small artificial drainage ditch running east to west along the north border of the disposal site also flows into Medora Creek.

7.1.3 BACKGROUND

This waste disposal site has been operating in its present site for over 20 years. In 1977, the site was registered with the Province as an existing waste disposal site. Present records show that this site serves approximately 1100 people. Primarily municipal waste from the Town of Deloraine and household waste from the surrounding rural areas are deposited at this site. A surficial deposition system is now used to dispose of these household, and municipal wastes.

Public water supply is derived from a surface water reservoir, located 7 Km southeast of town, and serves about 1100 people. The water is piped to a treatment and pumping station where the water is chlorinated, fluoridated, filtered, recarbonized, softened and coagulated and distributed. The area is served by a two cell sewage lagoon which discharges into Medora Creek upstream from the disposal site.

7.1.4 SITE CONDITIONS

During the site inspection on September 13, 1984, several observations were made. The site is located 500 m north of a Section Road, and covers an area of 160 m by 145 m. The active area consists of a mound of built up waste and fill 2.5 m high with a radius of 40 m. The disposal method is open deposition followed by burning, after which the waste is pushed over the mound embankment and covered with fill. There is also a separate area for agricultural chemical containers in the northwest corner of the site.

Overall the site is fairly well kept. Access to the site is adequate year round. The location of the site is suitable because no buildings are located in the site area; the nearest building being 1 Km away.

7.1.5 DRILLING AND SAMPLING

A drilling and sampling program was not undertaken for the Deloraine site.

7.2 GEOLOGIC DATA

7.2.1 GEOLOGIC SETTING

The area is located on the flat glacial till plains of southwestern Manitoba. This till forms a thick blanket of overburden covering bedrock. Some areas from Deloraine to the northeast, including the disposal site, feature a thin surface layer of lacustrine clay covering the till. These thin clays are sediments from the proglacial extent of Whitewater Lake and form the silty clay loam topsoil surrounding the site (see Figure 7.2).

7.2.2 BEDROCK

The underlying bedrock in this area consists of siltstone and shales from the Cretaceous Period. These sedimentary rocks are referred to as the Coulter Member of the Riding Mountain Formation and are commonly light grey with extensive fracture zones. The bedrock surface has been logged at around 30 metres depth and an elevation of 470 metres a.s.l.

7.2.3 OVERBURDEN

The overburden in this area consists of 30 metres of clayey calcareous till. This till unit features few silt and sand pockets, therefore no wells logs are available for this unit. A thin layer of silty lacustrine clay forms a heavy loam topsoil (see Figure 7.3).

7.2.4 GEOHYDROLOGY

The only aquifer reported in this area consists of saturated fracture zones in the siltstone and shale bedrock. This aquifer is confined by 30 metres of impermeable till overburden. Reports show this to be a brine aquifer and not potable.

The overburden does not support any reported water bearing zones, and thus, no shallow wells are reported in this area. Also, surface waters in this area are not expected to infiltrate or recharge the bedrock aquifer through the impermeable clay till.

7.3 ENVIRONMENTAL INTERPRETATION AND ASSESSMENT

7.3.1 LEACHATE HYDROLOGY

Leachate is produced on this site by infiltration of precipitation through the fresh and buried waste. Due to the impremeability of the clay till, little of this leachate can migrate deeper than a few metres into the subsurface.

During periods of high surface runoff, some leachates may be carried west into Medora Creek and into the agricutlural soil surrounding the site. The proximity of the agricultural chemical containers to the site periphery may also allow herbicides and pesticides leachate to affect the nearby topsoil.

7.3.2 METHANE

Based on the amount of waste deposited at this site an estimated 6 million cubic metres of methane gas may be produced per year. Since most of the waste is burned before fill covering and the site is reletively dry, the actual quantity of methane gas generated will only be a fraction of the estimate. Migration of any methane gas produced should be limited because waste is deposited above grade. Methane gas likely vents directly into the atmosphere with little subsurface migration.

7.3.3 WATER QUALITY

Water quality of the bedrock aquifer in this region is considered very poor due to its high salt content. No drinking water wells are reported in the region.

7.3.4 CONCLUSION

This site poses a very low environmental impact on the area. Since the local bedrock aquifer is confined by a thick impermeable till cover, the site has no effect on groundwater quality. Further, no drinking water wells are set into aquifer because the water is naturally saline and unpotable.

Spring melt and strong rainfall may cause occasional runoff from the site to travel west into Medora Creek. However, since the creek is used for the discharge of sewage effluent, the occasional runoff will not noticeably affect stream chemistry.

Methane gas migration is not of consequence on this site because no buildings are located in the area. However, leachate from the buried waste and the chemcial containers may affect the crops and topsoil for several meters around the site because no greenbelt or berm exists. Further, the site is nearly full and expansion or relocation are imminent.

7.3.5 RECOMMENDATIONS

a) The chemical container area should be located 30 metres or more from the site periphery to avoid adjacent crop damage.

b) A berm or greenbelt should be established around the site to avoid runoff from affecting agricultural topsoil, and to protect crops from fire damage.

c) The site is nearly fully utilized. Therefore, expansion or relocation should be considered.

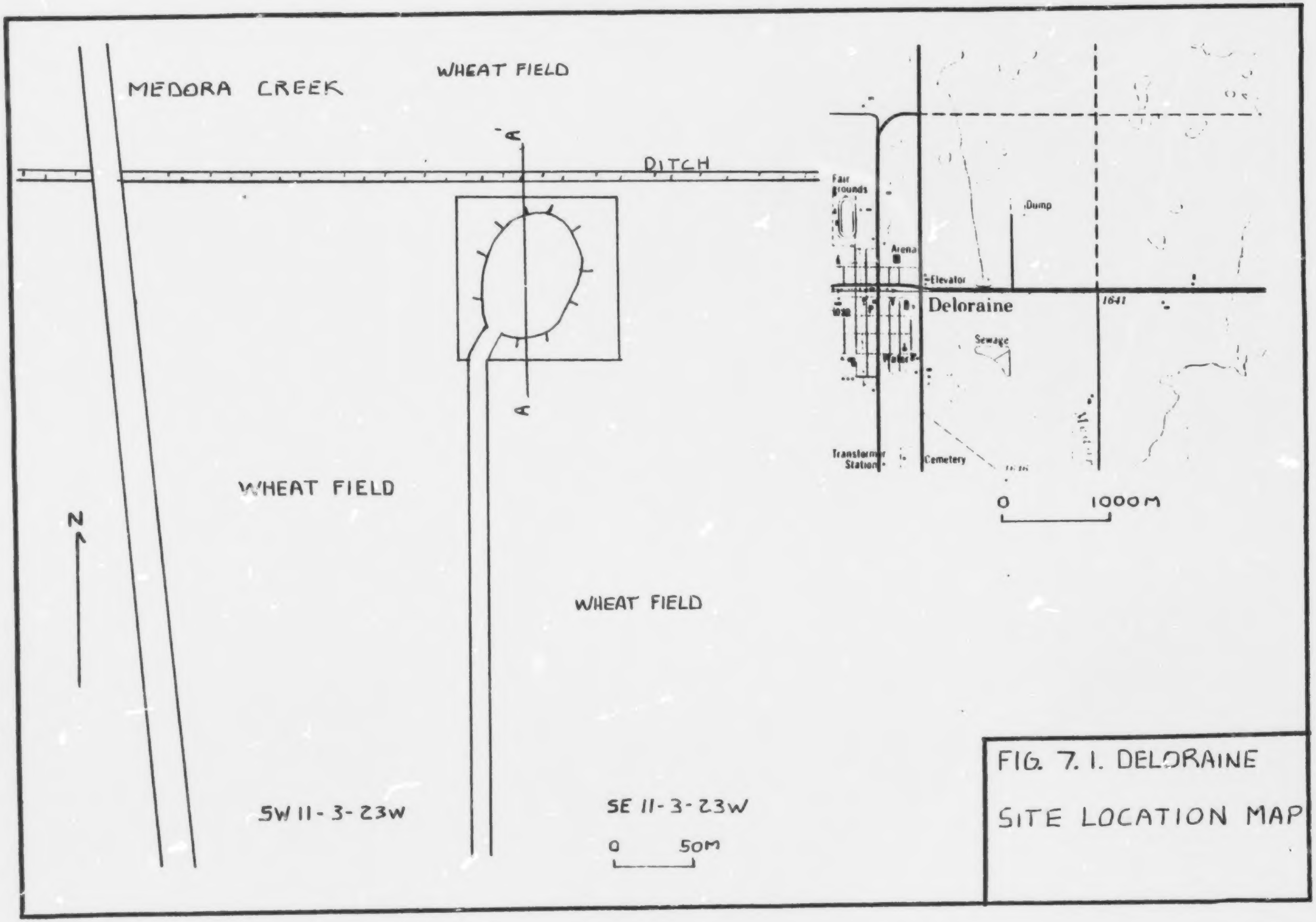

MEDORA CREEK
WHEAT FIELD
DITCH
A'
A
WHEAT FIELD
WHEAT FIELD
N
SW 11-3-23W
SE 11-3-23W
0
50M
Fair Grounds
Arena
Elevator
Dump
Deloraine
1641
Sewage
Water
Transformer Station
Cemetery
0
1000M

FIG. 7.1. DELORAINE SITE LOCATION MAP

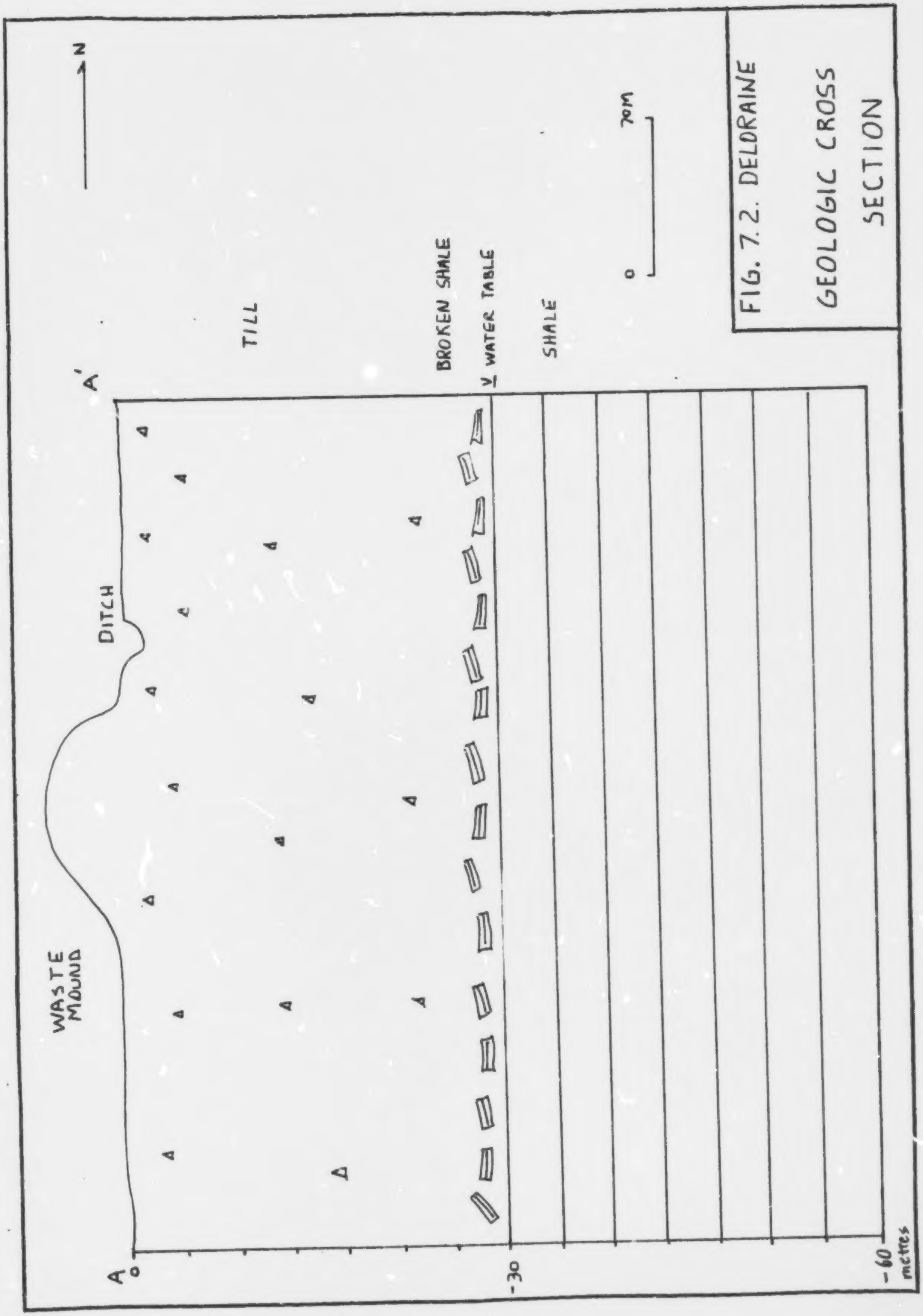

A
A'
N
WASTE MOUND
DITCH
TILL
BROKEN SHALE
WATER TABLE
SHALE
0
70M
0
-30
-60
metres

FIG. 7.2. DELORAINE GEOLOGIC CROSS SECTION

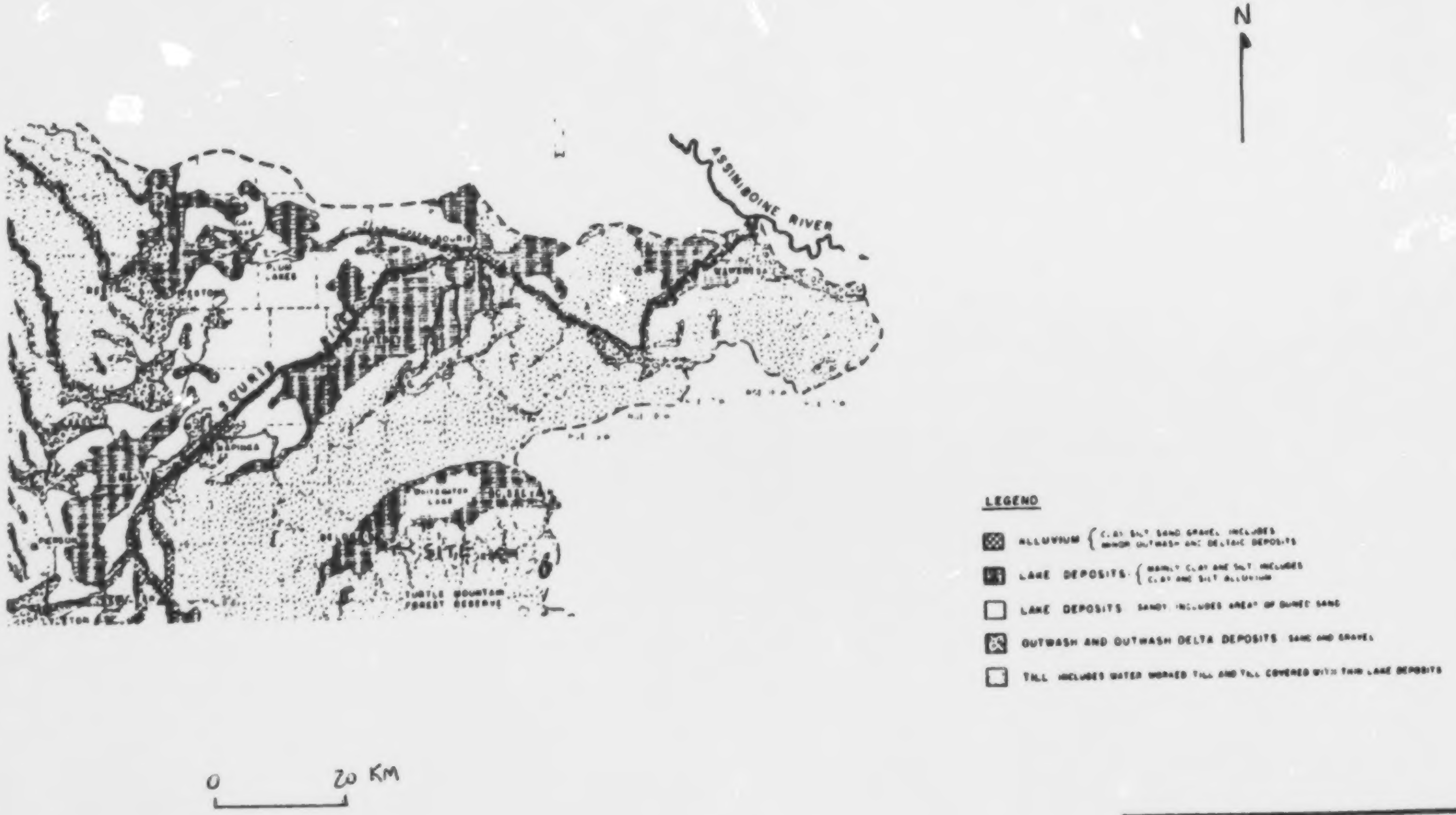

N
ASSINIBOINE RIVER
SOURIS RIVER
PLUM LAKES
WHITEWATER LAKE
SITE
TURTLE MOUNTAIN FOREST RESERVE
LEGEND
▩ ALLUVIUM { CLAY SILT SAND GRAVEL INCLUDES MINOR OUTWASH AND DELTAIC DEPOSITS
■ LAKE DEPOSITS { MAINLY CLAY AND SILT INCLUDES CLAY AND SILT ALLUVIUM
☐ LAKE DEPOSITS SANDY INCLUDES AREAS OF DUNED SAND
▨ OUTWASH AND OUTWASH DELTA DEPOSITS SAND AND GRAVEL
☐ TILL INCLUDES WATER WORKED TILL AND TILL COVERED WITH THIN LAKE DEPOSITS
0
20 KM

FIG. 7.3. DELORAINE

SURFICIAL DEPOSITS

MAP

CHAPTER - EIGHT -

GIMLI

R.M. OF Gimli

NE 16-19-3E

8 GIMLI WASTE DISPOSAL SITE

8.1 RECONNAISSANCE DATA

8.1.1 LOCATION

The Town of Gimli, Manitoba, is located within the R.M. of Gimli approximately 69 kilometres north of Winnipeg along P.T.H. 9 and P.R. 231. The waste disposal site is located about 8 kilometres south of P.R. 231 on Section NE 16-19-3E, (See Figure 8.1 and Figure 8.2).

8.1.2 PHYSIOGRAPHY

The area is located on lightly rolling basin flats of the Manitoba Interlake low lands, sloping into Lake Winnipeg. The area around the site features 2-3 metres relief with the lowest depressions filled with open water and sloughs. The site is situated in a depressed area, bordered to the north by ancient beach ridges.

Surficial drainage in the area and around the site is poor overall. There is a slight southeasterly dip in topography.

Vegetation in the area consist of about 80% cultivated fields and 20% wood and grassland. The disposal site is surrounded by poplar woods and interspersed small pastures.

8.1.3 BACKGROUND

The waste disposal site in Gimli was registered with the Province in 1977 as an existing waste disposal ground. Present records show the site serves approximately 5000 people. Primarily municipal waste from the Town of Gimli, and household waste and sewage from surrounding rural areas is deposited at this site. As well, industrial waste such as fish parts and paint cans are disposed of here. A combination of disposal techniques are used, open dumping of fish parts and open pit dumping of sewage waste and solid waste.

Water supply in the area is derived from deep limestone bedrock aquifers.

8.1.4 SITE CONDITIONS

A number of observations were made during a site inspection on September 26, 1984. The site is accessed from a gravelled Section Road running along the east side of the dump. A page wire fence along the road allowance with an approach from the road directs traffic onto the site.

A system of four mud trails and a loop give access to various parts of the site. A 30 x 30 metre excavated pit on the south part of the site serves as a dump for household wastes. The pit is dug below the groundwater table and is full of leachate from the waste. When sufficient waste has accumulated, it is bulldozed into the pit. The displacement forces the leachate to overflow and drain west through a small ditch into an adjacent slough. This slough connects along the west border of the site to a stretch of open pond along the north border. From here, excessive water flows through a culvert to a slough on the east side of the gravelled Section Road.

Just north of this disposal pit, following a mount of excavated gravel, a trail leads to a 40 x 40 metre natural pit used for the disposal of raw sewage. This sludge is covered with a layer of scum, debris and fish wastes. A trail of sewage gives evidence that this pit frequently overflows into the adjacent slough and the open pond. Large amounts of dead fish and fish wastes are dumped around the sewage pit and are strewn on all parts of the site. The septic sludge and the decaying fish remains create a foul odour, attracting excessive amounts of flies and insects breeding on the waste. And, more obvious, scores of gulls and other birds scavange on the wastes for food.

Immediately north lies a small pit featuring piles of burnt and unburned paint pails partially submerged in sewage and leachate. From this point, a mud trail loop gives access to the partially inactive disposal terrace covering most of the north half of the site. Part of this area serves separate shrub and metal disposal. The rest of the area consists of only incompletely covered piles and flats of unsorted wastes. The open pond to the north of this area has been partially filled by the encroaching disposal piles.

Overall, the open leachate pits, fish and sewage wastes, and the presence of numerous scavenging birds make this an undesirable site. The site is poorly organized and exposed organic wastes give off offensive odours.

8.1.5 DRILLING AND SAMPLING

A drilling program was not caried out at the Gimli site; however, five residential water samples and two surface water samples were collected on October 15, 1984. The sampling locations are indicated on the location map, Figure 8.1. Chemical analysis results are summarized in Table 8.1 and discussed in Section 8.3.3.

8.2 GEOLOGIC DATA

8.2.1 GEOLOGIC SETTING

Generally, this area consists of glacial till basin plains extending from Lake Winnipeg to Lake Manitoba. The till in this area is highly calcareous and varies from gravel to clay, and permeable to impermeable respectively.

Proglacial lake levels have previously inundated this area leaving thin clay and silt deposits covering the till in places; and at some elevations, sand and gravel beach ridges mark ancient lake levels (see Figure 8.3).

8.2.2 BEDROCK

The bedrock in this area consists of limestone and dolostone. Extensive zones of fracturing and cavities allow this rock unit to store and transmit water. The bedrock surface is approximately 35 metres below grade beneath the site at about 238 metres a.s.l.

8.2.3 OVERBURDEN

Three layers of overburden consists of three distinct layers beneath the site. The deepest consists of a thin layer of crushed limestone overlying bedrock. The middle layer consists of grey clayey, low permeability, highly calcareous till. The upper most layer consist of several metres of silty limestone and mixed brown till gravel with high permeability. The three layers compose the total of 35 metres of overburden (see Figure 8.4).

8.2.4 GEOHYDROLOGY

Two types of aquifers exist in this area. The major aquifer consists of the saturated and fractured bedrock zones at depth. All reported wells in this area are set into this bedrock aquifer. The second type of aquifer consists of surficial gravels. These gravel deposits are usually of limited extent and prone to pollution.

The disposal site is located directly on such a surficial gravel aquifer. The pits and trenches penetrate the water table at about 1 metre below the site surface. No wells are reported in this aquifer; however, surface waters are in direct hydraulic contact with the groundwater.

8.3 ENVIRONMENTAL INTERPRETATION AND ASSESSMENT

8.3.1 LEACHATE HYDROLOGY

Leachates enter the groundwater from the various active and inactive disposal areas of the site. Production of leachate, and pollution of ground and surface water on the site is extensive. Since the disposal pits penetrate the water table, leachate is produced continuously, independent of precipitation.

The bedrock aquifer at depth is not likely to be significantly affected because the low permeability, grey till separates it from the polluted gravel aquifer.

8.3.2 METHANE

Based on the amount of waste deposited at this site an estimated 20 million cubic metres of methane gas may be produced per year. The estimated migration of any methane gas generated should be approximately 30 metres based on the permeability of the soil. Since most of the waste is unburned and buried in wet condition beneath the water table, actual production of gas may be approaching the theoretical maximum.

8.3.3 WATER QUALITY

The basic water quality of the limestone aquifer is good. The basic chemical constituents for samples 3 to 7 indicate a carbonate soil environment as evidenced by the hardness, pH and calcium, magnesium and alkalinity values. Overall no evidence of contamination was found in samples 3 to 7. The water qualities for samples 3 to 7, except 6, can be considered good, with all tested parameters well below objective limits.

In sample 6 the water quality can be considered fair. The water here is more salty, with higher levels of sulphate, chloride, nitrate, sodium and total residue. All levels of parameters were found to be well below objective limits. The occurence of the higher levels of ions and dissolved solids is most likely natural in occurence, and not indicative of a contamination problem.

Samples 1 and 2, taken from the leachate pond and swamp, show definite levels of contamination. Major changes in pH, residue, conductivity, iron, potassium, sodium, COD, TOC, turbidity, nitrate, phosphate, chloride and sulphate were found. Some of the parametres have concentrations well above maximum acceptable limits for surface water, for example, bacteria levels. Figure 8.2 shows locations of samples 1 to 7 while Table 8.1 shows exact concentrations of the chemical parameters.

8.3.4 CONCLUSION

This site poses a high environmental impact in the area. Leachates contaminate the ponds and other open water around the site. Bacteria levels have been found to be very high. Leachate contamination of ground water is occurring in the shallow gravel aquifer beneath the site. However, drinking water in the area is not affected because all local wells are set into the bedrock aquifer at depth. Water samples showed no evidence of pollution in this aquifer.

Methane migration is not suspected to be a problem at this site because no buildings exist within the migration perimeter.

Insects and birds pose a potential health hazard. Also, the offensive odors given off by the exposed organic wastes make it an undesirable disposal site. Overall, this site is environmentally and aesthetically unacceptable.

8.3.5 RECOMMENDATIONS

1. Steps should be taken to relocate this site immediately.

2. In the interim:

   a) Waste should not be buried below the groundwater table. Given the circumstances, this means surface dumping and covering with borrow materials for the remainder of site activity.

   b) Sewage dumping should be discontinued at this site.

   c) Fish and other organic waste should be covered on a daily basis.

   d) Site upkeep and organization should be improved to avoid strewn fish and household wastes on the inactive parts of the site.

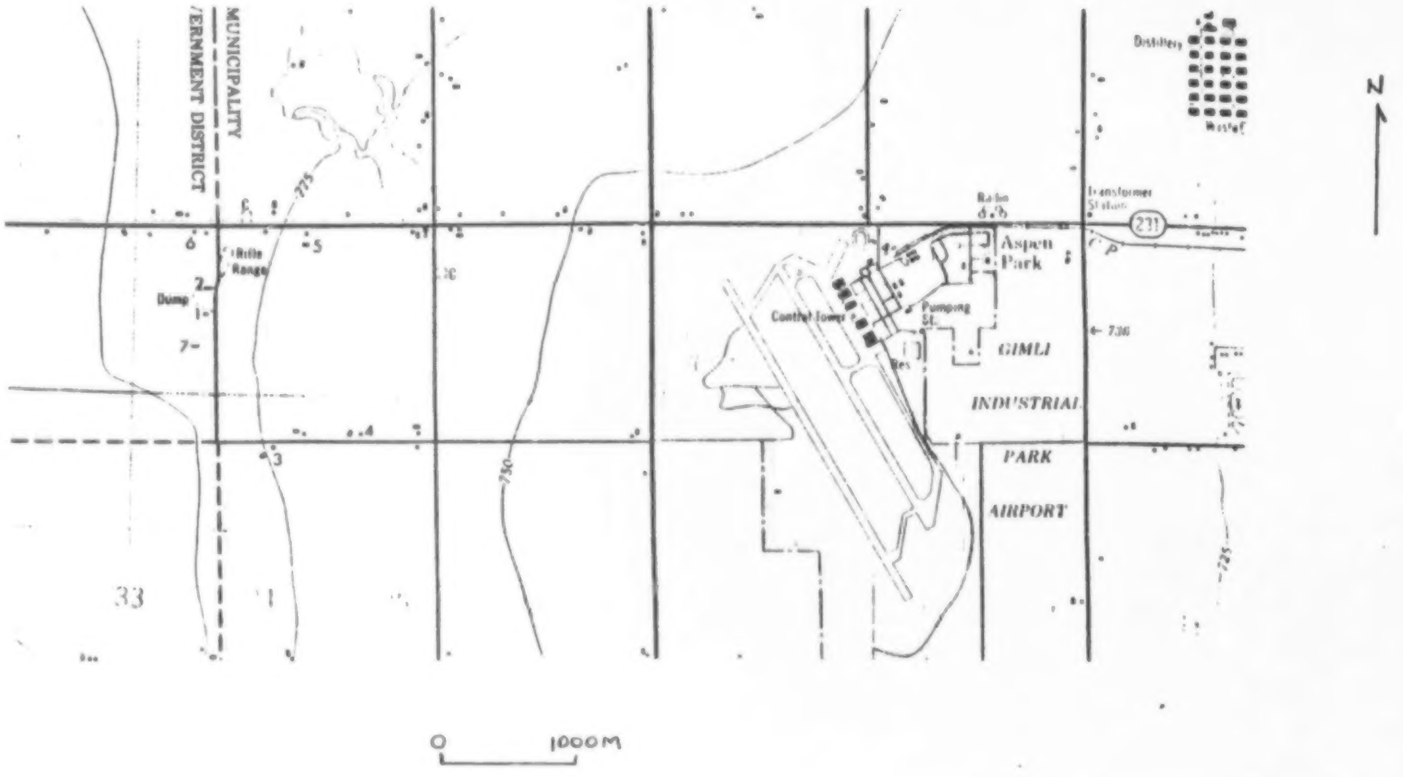

N
Distillery
Hostel
Transformer Station
231
C P
Radio
Aspen Park
Pumping St.
Control Tower
Res
← 736
GIMLI
INDUSTRIAL
PARK
AIRPORT
725
750
36
MUNICIPALITY
/ERNMENT DISTRICT
Rifle Range
Dump
1
2
3
4
5
6
7
33
0
1000M

FIG. 8.1. GIMLI
SITE LOCATION MAP

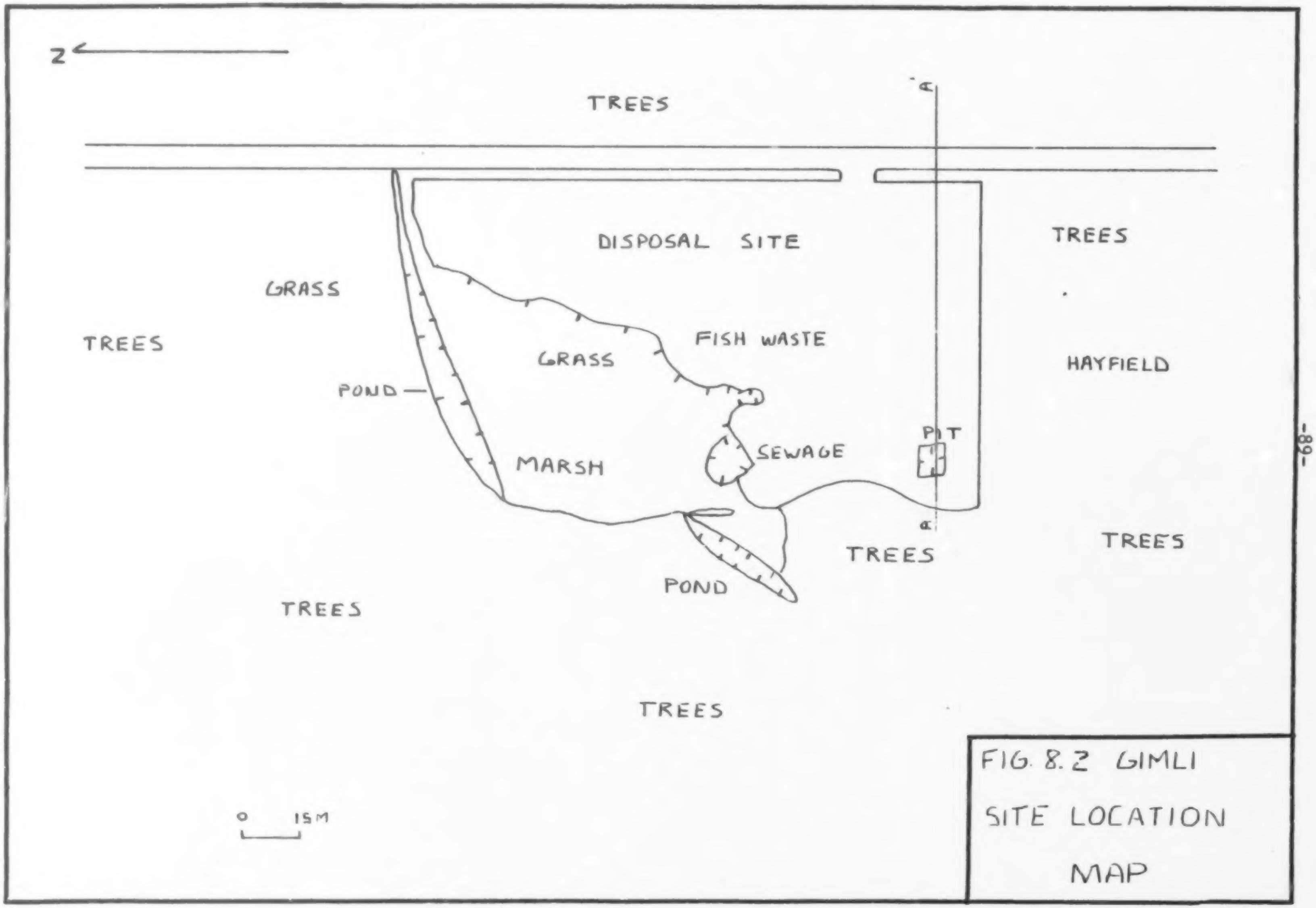

N
TREES
DISPOSAL SITE
TREES
GRASS
TREES
FISH WASTE
GRASS
HAYFIELD
POND
PIT
SEWAGE
MARSH
TREES
TREES
POND
TREES
TREES
0
15M

FIG. 8.2 GIMLI SITE LOCATION MAP

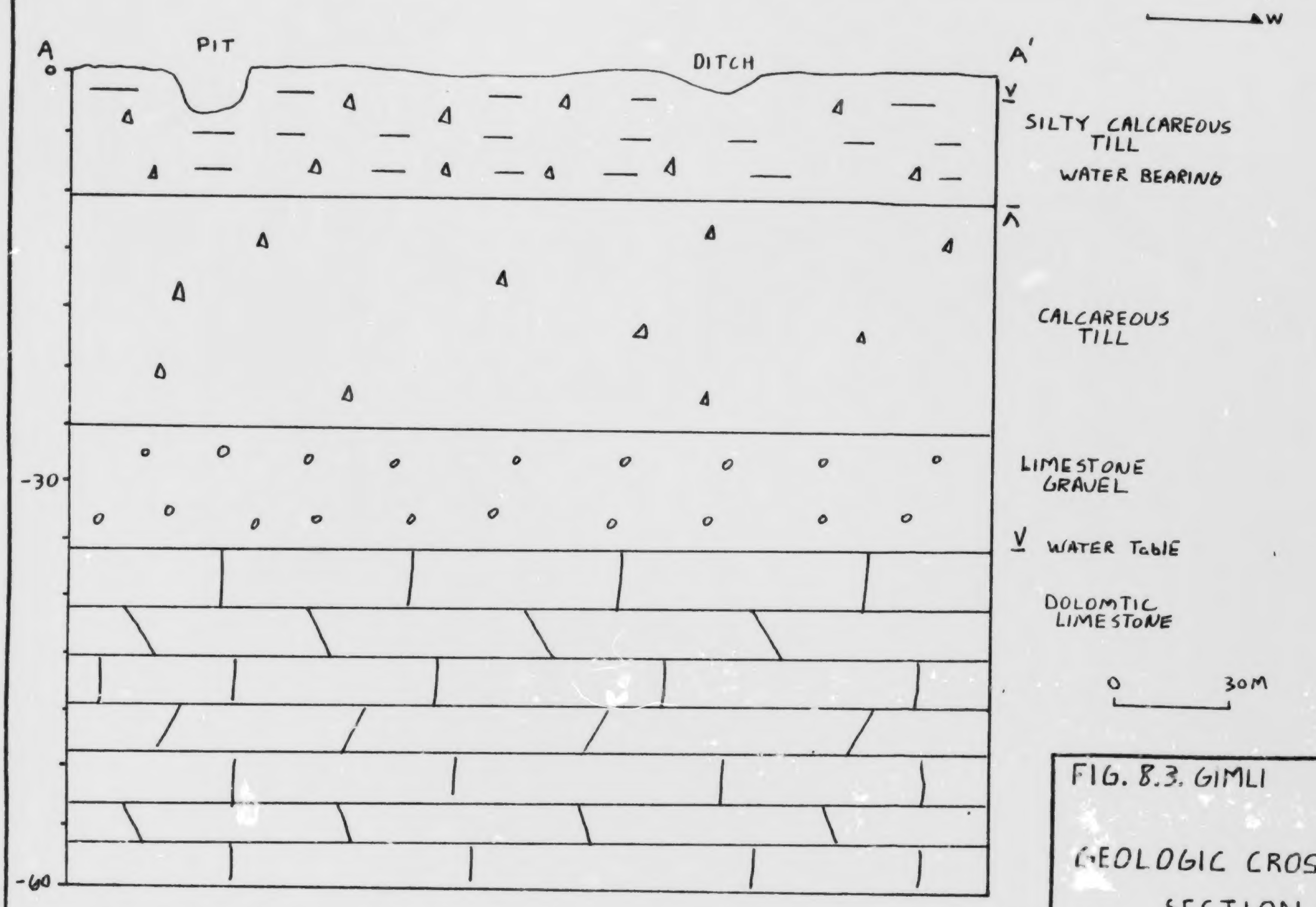

W
A
A'
PIT
DITCH
SILTY CALCAREOUS TILL
WATER BEARING
CALCAREOUS TILL
LIMESTONE GRAVEL
WATER Table
DOLOMTIC LIMESTONE
0
-30
-60
0
30M

FIG. 8.3. GIMLI

GEOLOGIC CROSS SECTION

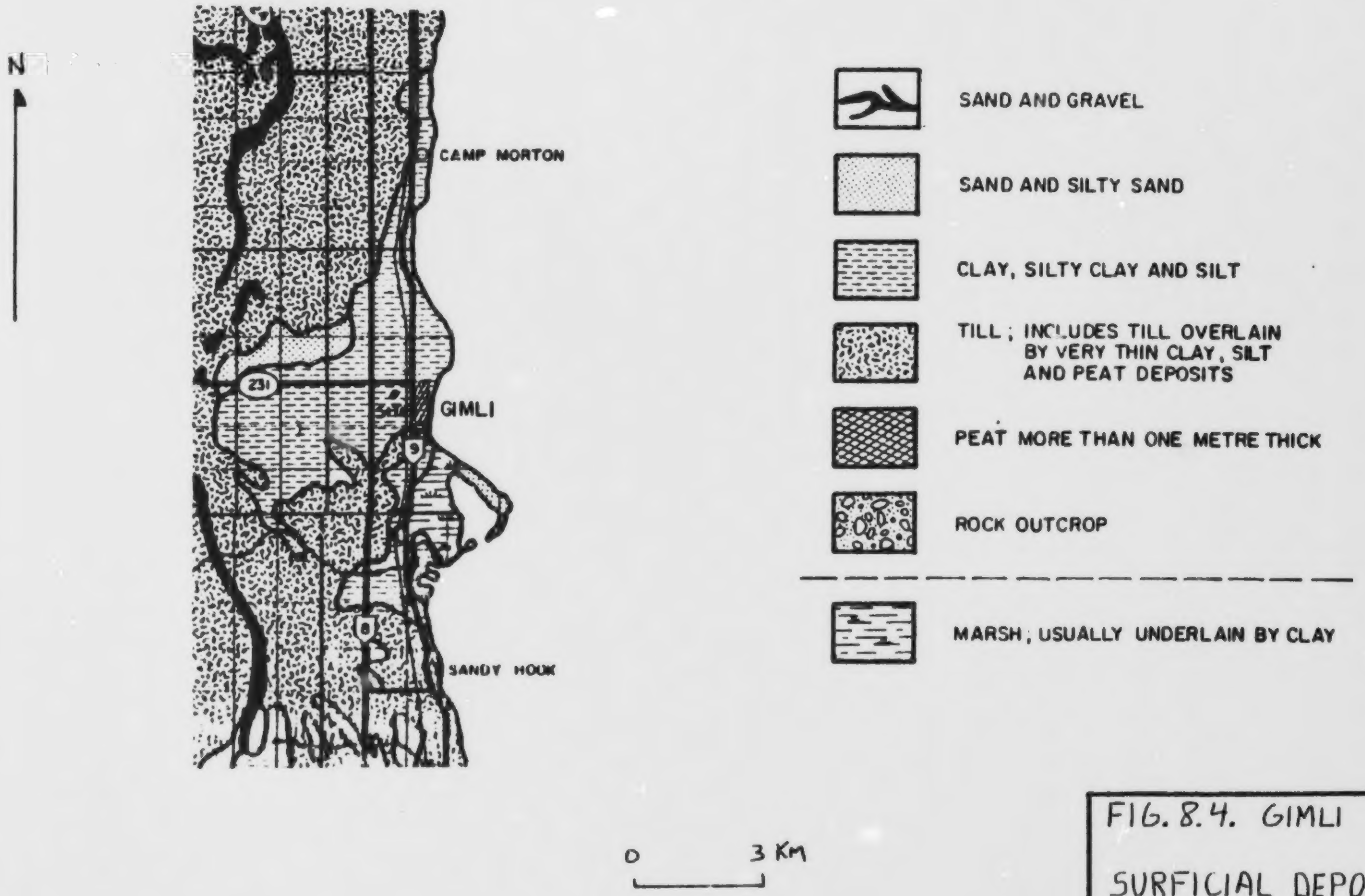

N
CAMP MORTON
231
GIMLI
SANDY HOOK
SAND AND GRAVEL
SAND AND SILTY SAND
CLAY, SILTY CLAY AND SILT
TILL ; INCLUDES TILL OVERLAIN BY VERY THIN CLAY, SILT AND PEAT DEPOSITS
PEAT MORE THAN ONE METRE THICK
ROCK OUTCROP
MARSH ; USUALLY UNDERLAIN BY CLAY
0
3 KM

FIG. 8.4. GIMLI

SURFICIAL DEPOSITS

MAP

TABLE 8. 1. GIMLI

Site Number	1	2	3	4
Parameters				
Conductivity umho/cm	2580	867	727	803
Residue Total mg/L	1570	660	460	500
Residue Filt mg/L	1540	530	460	500
Residue Non-Filt mg/L	30	130	<5.0	<5.0
pH units	8.55	7.85	7.55	7.50
Alkal. Total ($CaCO_3$) mg/L	652	292	354	458
Alkalinity (HCO_3) mg/L	747	356	432	559
Alkalinity (CO_3) mg/L	24	0	0	0
Alkalinity (OH) mg/L	0	0	0	0
As (Ext.) mg/L	<.001	<.001	.003	<.001
Cd (Ext.) mg/L	0	.001	.001	<.001
Cu (Ext.) mg/L	.03	.03	<.01	.03
Pb (Ext.) mg/L	<.005	<.005	<.005	<.005
Ni (Ext.) mg/L	<.005	<.005	<.005	<.005
Zn (Ext.) mg/L	.05	.05	.15	.38
Cr (Total) mg/L	.02	.036	<.005	.007
Calcium (Ext.) mg/L	28.6	63.8	50.3	48.1
Magnesium (Ext.) mg/L	102	58.1	65.5	82.3
Hardness ($CaCO_3$) mg/L	490	398	394	458
Manganese (Ext.) mg/L	.06	.12	<.02	<.02
Iron (Ext.) mg/L	1.10	1.46	.57	.59
Potassium (Ext.) mg/L	230	28.0	<5.00	<5.00
Sodium (Ext.) mg/L	245	48.4	33.3	25.4
COD mg/L	180.	93.	12.	7.
T.O.C. mg/L	88	25.5	10.5	47.0
Turbidity NTU	6.5	8.0	.65	.65
CN (Free) mg/L	<.02	<.02	<.02	<.02
Kieldnal, Total-N mg/L	10.6	1.2	.20	.35
NH_3-N (Sol.) mg/L	5	.03	.09	.15
NO_3-NO_2-N (Diss.) mg/L	.12	.02	.11	.03
P-Total mg/L	.55	.20	<.01	<.01
Chloride (Sol.) mg/L	490	69	4.0	3.0
Sulphate (Sol.) mg/L	10	70	75	30
Fecal Coliform /100 mL	500	10	<10	<10
Total Coliform /100 mL	5400	200	<10	<10

TABLE 8.1. GIMLI

Site Number	5	6	7	
Parameters				
Conductivity umho/cm	794	946	845	
Residue Total mg/L	500	600	520	
Residue Filt mg/L	500	600	520	
Residue Non-Filt mg/L	<5.0	<5.0	<5.0	
pH units	7.40	7.50	7.45	
Alkal. Total (CaCO$_3$) mg/L	460	450	464	
Alkalinity (HCO$_3$) mg/L	561	549	566	
Alkalinity (CO$_3$) mg/L	0	0	0	
Alkalinity (OH) mg/L	0	0	0	
As (Ext.) mg/L	.003	.001	.004	
Cd (Ext.) mg/L	<.001	<.001	<.001	
Cu (Ext.) mg/L	<.01	<.01	<.01	
Pb (Ext.) mg/L	<.005	<.005	<.005	
Ni (Ext.) mg/L	<.005	<.005	<.005	
Zn (Ext.) mg/L	.26	.89	1.77	
Cr (Total) mg/L	.006	<.005	<.005	
Calcium (Ext.) mg/L	46.7	56.8	47.	
Magnesium (Ext.) mg/L	81.2	89.3	80.	
Hardness (CaCO$_3$) mg/L	450	508	447.	
Manganese (Ext.) mg/L	<.02	<.02	<.02	
Iron (Ext.) mg/L	1.06	.08	.34	
Potassium (Ext.) mg/L	<5.0	<5.0	5.0	
Sodium (Ext.) mg/L	20.3	26.7	20.0	
COD mg/L	10	14	4	
T.O.C. mg/L	12	12.5	49	
Turbidity NTU	5.0	.45	.30	
CN (Free) mg/L	<.02	<.02	<.02	
Kieldnal, Total-N mg/L	.30	.40	.30	
NH$_3$-N (Sol.) mg/L	.15	.02	.19	
NO$_3$-NO$_2$-N (Diss.) mg/L	<.01	8.60	<.01	
P-Total mg/L	<.01	.06	<.01	
Chloride (Sol.) mg/L	3.0	27	3.0	
Sulphate (Sol.) mg/L	25.	35	22.	
Fecal Coliform /100 mL	<10	<10	<10	
Total Coliform /100 mL	<10	<10	<10	

CHAPTER - NINE -

GILBERT PLAINS

R.M. OF GILBERT PLAINS

NE 10-25-22W

9 GILBERT PLAINS WASTE DISPOSAL SITE

9.1 RECONNAISSANCE DATA

9.1.1 LOCATION

The Town of Gilbert Plains, Manitoba, is located in the R.M. of Gilbert Plains, 270 km northwest of Winnipeg, off P.T.H. 5. The waste disposal site is located on the southeast border of the town on Section NE 10-25-22W (see Figure 9.1).

9.1.2 PHYSIOGRAPHY

This area is part of the flat open prairie which connects the Duck and Riding Mountains. The Valley River which runs as a misfit stream in an ancient proglacial valley is incised 20 to 25 metres below the prairie landscape. The banks of the valley are very steep and overgrown with trees; the valley floor features wet pasture, small woods and marshland.

One half of the site is located at the top of the south bank on the open prairie, the other covers a clearing down the valley bank into a wet pasture below. Drainage is directly from the site into the valley.

9.1.3 BACKGROUND

The waste disposal site has been operating on the outside of a meander loop for approximately several decades. In 1977, the site was registered with the Province as an existing waste disposal ground. Current records show that this site serves approximately 900 people. Primarily municipal waste from the Town of Gilbert Plains and household waste from surrounding rural areas is deposited at this site.

Approximately 4 km upstream of the site treated water is derived from the Valley River for the town water supply. Rural residents derive groundwater from private wells. A sewage lagoon is located in the valley 300 metres west of the disposal site and discharges into the Valley River.

9.1.4 SITE CONDITIONS

During the site inspection on September 19, 1984, several observations were made. The site is located at the southeast border of town, approximately 150 metres south of the nearest house. Access to the site is on an all weather road leading from the road south onto the site.

The site covers about 2 hectares, with an active area of 50 m by 30 m. The waste disposal method is open dumping over the embankment and into the valley below. Separate bulky metallic and agricultural chemical container areas are in place.

Half of the site, atop the valley banks, is very well kept; the grass around the metals area is cut regularly and well fenced in. No strewn waste and debris lies outside the small open disposal area. The waste is deposited in piles, burned and pushed over the embankment.

On the valley half of the site, the waste is fully exposed since little fill is used in this operation. Waste covers the entire height of the embankment and fallen waste litters the valley floor below.

Historic slumping of the oversteepend valley banks and associated waste is evident. Overall, the waste mound appears unstable.

9.1.5 DRILLING AND SAMPLING

Two hand augered wells were installed at the base of the embankment on October 10, 1984. The locations are indicated by numbers 1 and 2 on Figure 9.1. Soil logs are summarized in Table 9.2. The wells were frozen during the routine sampling visit on December 05 and no samples were taken.

Two private wells (see Figure 9.1) were sampled on a nearby feedlot. The results from the chemical analyses are discussed in Section 9.3.3 and summarized in Table 9.1.

9.2 GEOLOGIC DATA

9.2.1 GEOLOGIC SETTING

The part of the site, on top of the embankment, is situated on several metres of silt while the valley is underlain by glacial till. Alluvial clays overly the till in the valley floor (see Figure 9.2).

9.2.2 BEDROCK

Dark shales from the Cretaceous Period form the bedrock about 40 m beneath the prairie.

9.2.3 OVERBURDEN

The valley is underlain by about 20 m of glacial till. A thin alluvium deposit covers the valley floor. The open prairie is underlain by about 40 m of overburden. An estimated 34 m of till overlies bedrock, and 6 m of lacustrine silt forms the surficial deposit. The valley banks consists of silt which has slumped down the oversteepend slopes (see Figure 9.3).

9.2.4 GEOHYDROLOGY

Fresh water aquifers in the area are limited. Saturated fracture zones in the bedrock contain poor quality water which is not potable.

Gravelly zones of the till and confined lenses of sand in the overburden form the only fresh water aquifers. Water tables range from a few metres below grade in the valley to over 10 metres below grade on the top of the banks. Groundwater flow is towards the valley.

9.3 ENVIRONMENTAL INTERPRETATION AND ASSESSMENT

9.3.1 LEACHATE HYDROLOGY

Leachate is generated at this site when precipitation and runoff infiltrate through the waste on the embankment. The amount of leachate generated should be small since the waste is usually dry.

Contamination of groundwater should only occur locally at the base of the banks below the waste. Wells and drinking water are not likely to be affected by this process.

9.3.2 METHANE

Based on the amount of waste deposited at the site, an estimated 6 million cubic metres of methane gas may be produced per year. Since waste is burned before burial, the actual quantity of methane gas produced will only be a fraction of the estimate.

Since waste is deposited above grade, methane gas migration should be limited, and likely vents directly into the atmosphere with little sub-surface migration.

9.3.3 WATER QUALITY

Chemical analyses of the two water samples, well 3 and 4, can be found in Table 9.1. The water qualities are fair but somewhat less than expected for this area. Since the wells are located on a feedlot and cattle watering station, local feedlot and/or septic well contamination is suspected. Influence by the landfill site is not likely.

9.3.4 CONCLUSION

The slopes of the valley banks are oversteepened and previous slumping can be observed. The method of disposal over the edge of the embankment further decreases slope stability. A danger of future slumping exists, posing a possible hazard to man and equipment on the embankment.

9.3.5 RECOMMENDATIONS

a) Disposal of waste over the embankment should be discontinued. A new active area should be established no closer than 30 metres from the edge of the embankment. Since the amount of space available at this site is limited, expansion or relocation may be necessary.

b) Strewn debris on the valley floor should be collected and all exposed wastes should be covered with suitable fill material.

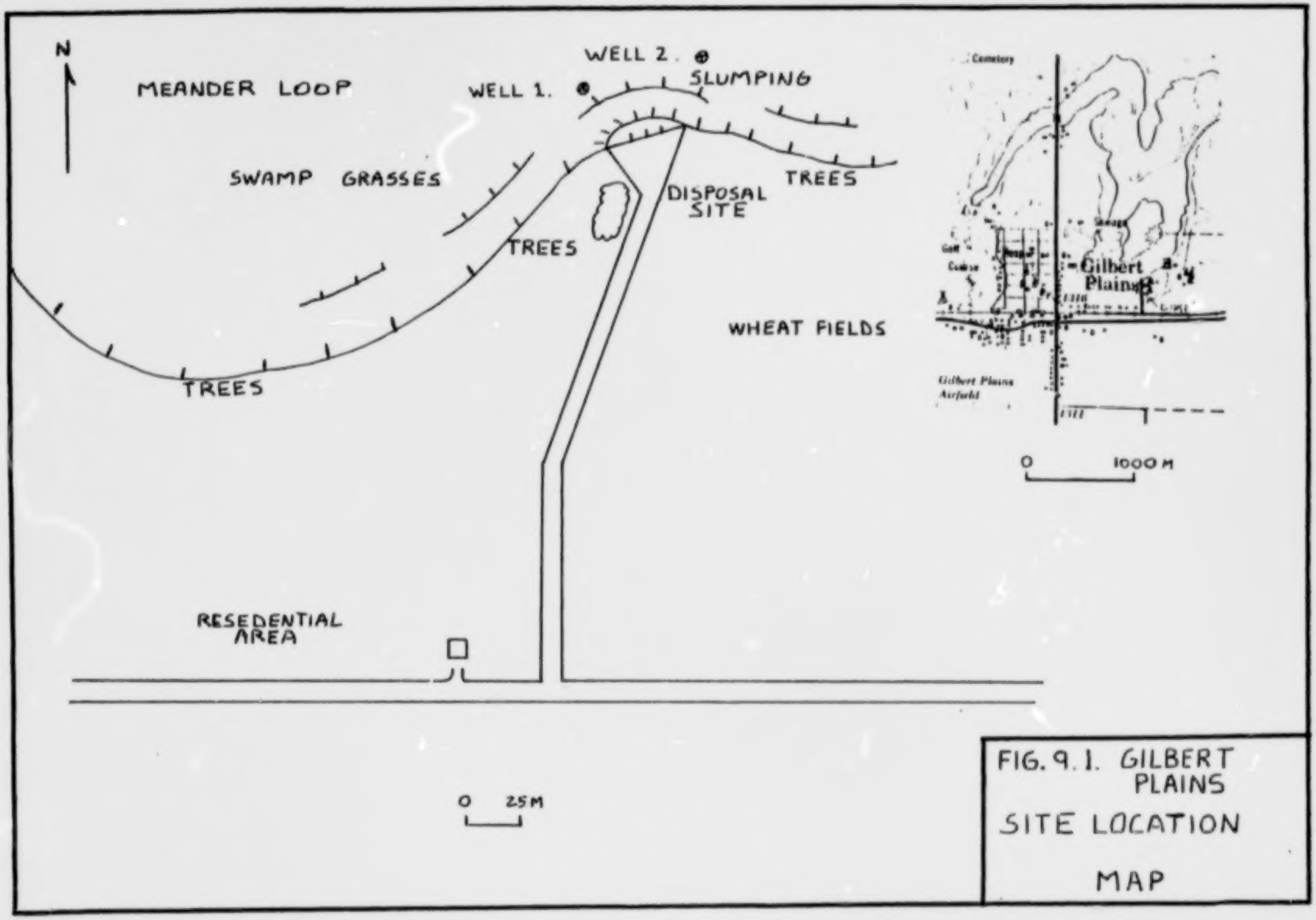

N
MEANDER LOOP
WELL 1.
WELL 2.
SLUMPING
SWAMP GRASSES
TREES
DISPOSAL SITE
TREES
TREES
WHEAT FIELDS
RESEDENTIAL AREA
0 25M
Cemetery
Golf Course
Gilbert Plains
Gilbert Plains Airfield
0 1000M

FIG. 9.1. GILBERT PLAINS SITE LOCATION MAP

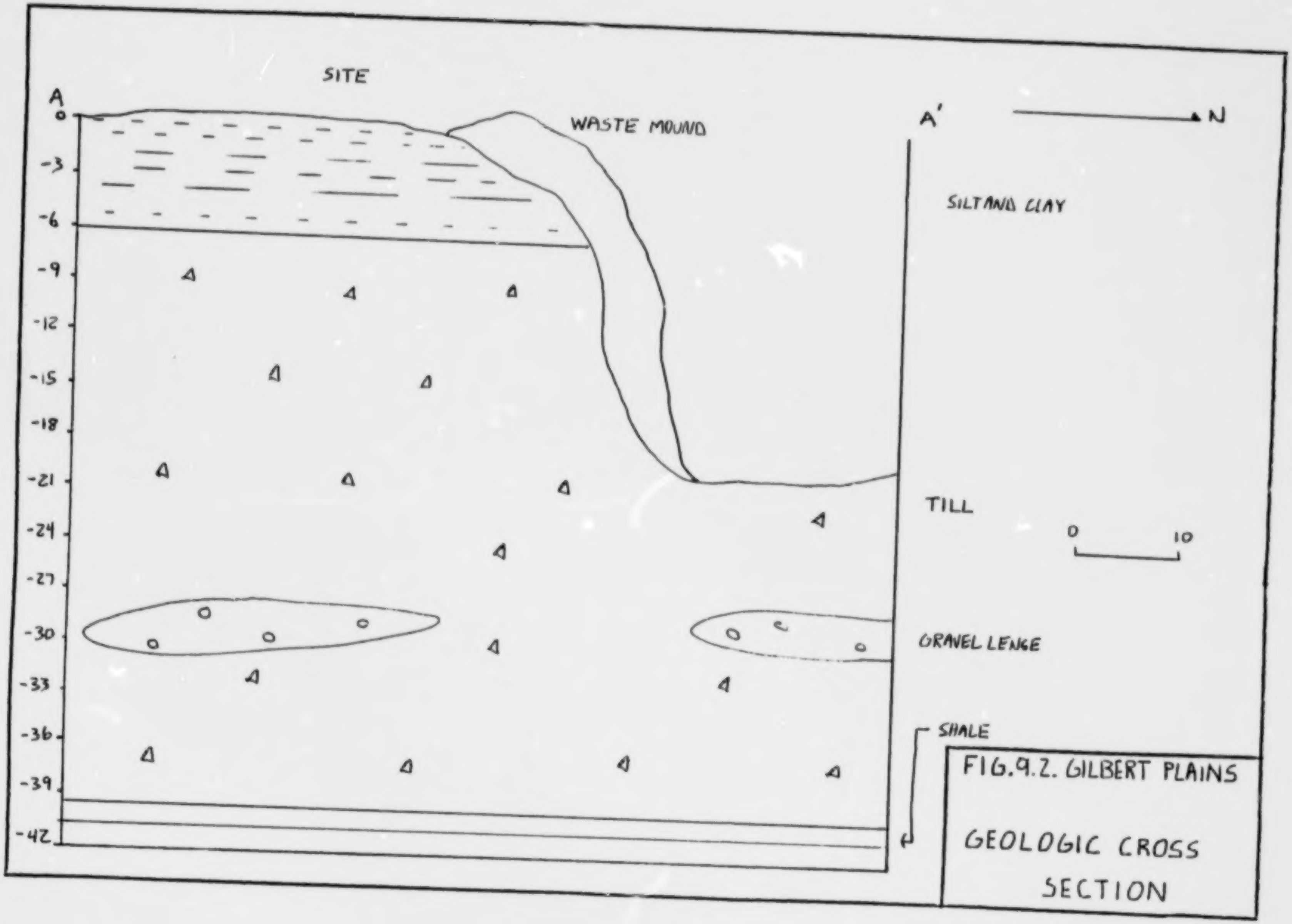

SITE
A
A'
WASTE MOUND
N
SILTAND CLAY
TILL
0
10
GRAVEL LENSE
SHALE
0
-3
-6
-9
-12
-15
-18
-21
-24
-27
-30
-33
-36
-39
-42

FIG.9.2. GILBERT PLAINS

GEOLOGIC CROSS SECTION

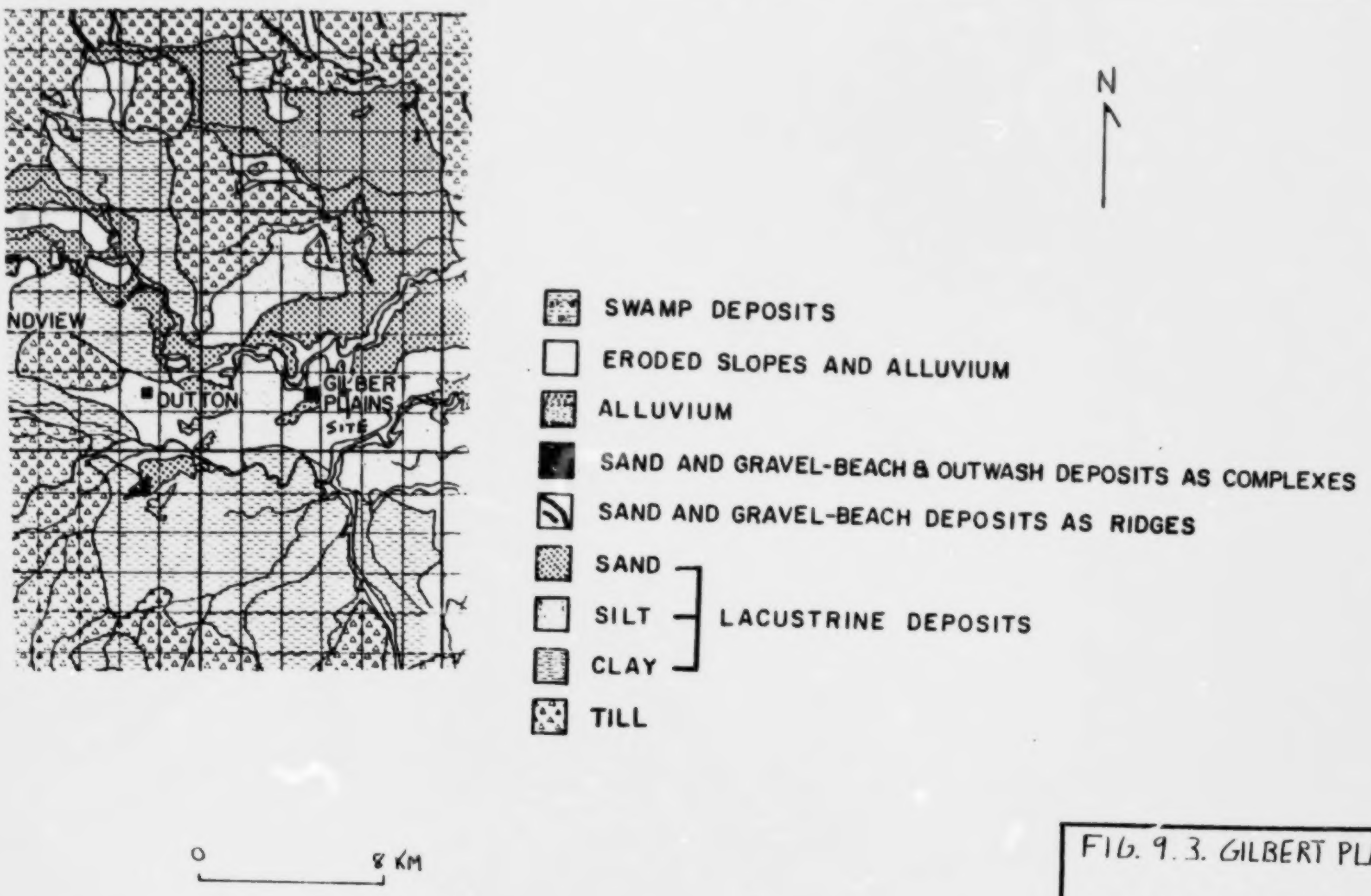

NDVIEW
DUTTON
GILBERT PLAINS
SITE
N
0
8 KM
▨ SWAMP DEPOSITS
☐ ERODED SLOPES AND ALLUVIUM
▨ ALLUVIUM
■ SAND AND GRAVEL-BEACH & OUTWASH DEPOSITS AS COMPLEXES
▨ SAND AND GRAVEL-BEACH DEPOSITS AS RIDGES
▨ SAND
☐ SILT
▨ CLAY
LACUSTRINE DEPOSITS
▨ TILL

FIG. 9.3. GILBERT PLAINS SURFICIAL DEPOSITS MAP

TABLE 9.1. GILBERT PLAINS

Site Number	3	4		
Parameters				
Conductivity umho/cm	1590	1220		
Residue Total mg/L	1520	840		
Residue Filt mg/L	1290	840		
Residue Non-Filt mg/L	230	<5		
pH units	7.25	7.10		
Alkal. Total ($CaCO_3$) mg/L	536.	392		
Alkalinity (HCO_3) mg/L	654	478		
Alkalinity (CO_3) mg/L	0	0		
Alkalinity (OH) mg/L	0	0		
As (Ext.) mg/L	.001	<.001		
Cd (Ext.) mg/L	<.001	.04		
Cu (Ext.) mg/L	.05	<.005		
Pb (Ext.) mg/L	<.005	<.005		
Ni (Ext.) mg/L	.006	<.005		
Zn (Ext.) mg/L	.90	.04		
Cr (Total) mg/L	.008	.009		
Calcium (Ext.) mg/L	211	141		
Magnesium (Ext.) mg/L	97.9	70.7		
Hardness ($CaCO_3$) mg/L	929	642		
Manganese (Ext.) mg/L	1.06	<.02		
Iron (Ext.) mg/L	4.97	.05		
Potassium (Ext.) mg/L	8.50	<5.0		
Sodium (Ext.) mg/L	29.3	11.3		
COD mg/L	53	10		
T.O.C. mg/L	16.0	8.5		
Turbidity NTU	75	.30		
CN (Free) mg/L	<.02	<.02		
Kjeldnal, Total-N mg/L	1.5	.40		
NH_3-N (Sol.) mg/L	.92	.02		
NO_3-NO_2-N (Diss.) mg/L	.03	36		
P-Total mg/L	.29	<.01		
Chloride (Sol.) mg/L	25	29		
Sulphate (Sol.) mg/L	430	135		
Fecal Coliform /100 mL	-	<1		
Total Coliform /100 mL	<1	<1		

TABLE 9.2 GILBERT PLAINS SOIL LOGS

WELL #	DEPTH (METRES)	DESCRIPTION
1	0 - 0.3	organic clay
	0.3 - 1	silt and clay
	1 - 1.5	sandy silt
2	0 - 1.2	organic silt
	1.2 - 1.3	silt

CHAPTER - TEN -

GLENBORO

R.M. OF SOUTH CYPRESS

SE 21-7-14W

10 GLENBORO WASTE DISPOSAL SITE

10.1 RECONNAISSANCE DATA

10.1.1 LOCATION

The Town of Glenboro is located in the R.M. of South Cypress, approximately 152 km west-southwest of Winnipeg along P.T.H. 2. The waste disposal site is located about 3.5 km northwest of the town on Section SE 21-7-14W, (see Figure 10.1).

10.1.2 PHYSIOGRAPHY

The area is located on the lightly rolling sandflats of the Assiniboine Delta which connect the Manitoba Lowlands with the Southwestern Uplands. To the north of the site, remnants of ancient dune formations form sand hills which are evidence of ancient aeolean activity on the delta.

Land use and vegetation consists of agricultural fields on the sand flats south, and semi-arid grasslands north of the site. The sand hills 500 metres north of the site feature pine and oak tree cover.

The area lacks drainage. It appears that the ground is permeable enough to absorb precipitation rapidly. The absence of ponds and sloughs suggests that the water table is generally below grade throughout the area.

10.1.3 BACKGROUND

This waste disposal site has been operating in its present location for over 12 years. In 1977, the site was registered with the

Province as an existing waste disposal site. Current records show that this site serves approximately 1300 people. Primarily municipal waste from the Town of Glenboro and household waste from surrounding rural areas is deposited at this site. A trench system is used to dispose of common waste, while bulky metallic wastes are collected on the surface. Rural water supplies are privately owned and derived from shallow wells.

10.1.4 SITE CONDITIONS

During the site inspection on September 12, 1984, several observations were made. The site is located off a Section Road running east-west along the site. The site is 800 metres long and 75 metres wide. Only the west end of the site is currently in use. A trench, 10 m by 50 m by 3 m in depth, and separate piles for metallic waste and agricultural chemical containers make up the active part of the site. The waste in the trench is generally burned, and when full, covered with fill.

The site location and condition are both good. The site is fenced and well kept, and the nearest residence is over 1 km away.

10.1.5 DRILLING AND SAMPLING

On November 19, 1984, two monitoring wells were installed on the site as indicated on Figure 10.1. The soil logs are summarized in Table 10.2

On January 3, 1985, water samples were taken from both wells and submitted for water quality analysis. Water quality of the monitoring wells are discussed in Section 10.3.3 and the results summarized in Table 10.1.

10.2 GEOLOGIC DATA

10.2.1 GEOLOGIC SETTING

The site is located on an extensive surficial sand unit which is part of the proglacial Assiniboine Delta deposits. The sand is interbedded with silts and clays at depth which overly glacial till (see Figure 10.2).

10.2.2 BEDROCK

At a depth of 67 metres, shale bedrock from the Cretaceous Period underlies the site.

10.2.3 OVERBURDEN

Two distinct units form 67 metres of overburden covering bedrock. The lower unit consists of 35 metres of dense calcareous till. The upper unit consists of 32 metres of deltaic deposits. At depth, interbedded clays and silts compose the unit while the surficial 13 metres consist of fine grained sand (see Figure 10.3).

10.2.4 GEOHYDROLOGY

The site is located on a major aquifer formed by the surficial sand unit. Several wells, including the monitoring wells, are set into this aquifer. The nearest drinking water well is located over one kilometer away from the site.

At 13 metres depth, a low permeability clay forms the lower aquifer boundary. The water table is 5.5 metres below the site.

10.3 ENVIRONMENTAL INTERPRETATION AND ASSESSMENT

10.3.1 LEACHATE HYDROLOGY

The sand unit beneath the disposal site forms a major aquifer; therefore, this area is pollution sensitive. Leachates, generated by infiltration permeating through the waste, can migrate freely to the water table.

It is anticipated that during times of aquifer recharge by snowmelt and major precipitation, local contamination of the groundwater can occur.

10.3.2 METHANE

Based on the amount of waste deposited, an estimated of 4.5 million cubic metres of methane gas per year may be produced at this site. Since the waste is burned before burial, the actual quantity of methane gas generated will only be a fraction of the estimate. The migration distance of any methane gas produced should be less than 50 m based on the permeability of the soil.

10.3.3 WATER QUALITY

Chemical analyses of water samples taken from the two monitoring wells (see Table 10.1) indicates contamination of groundwater may be occurring. The north monitoring well (sample 1) shows chemical parameters exceeding maximum acceptable concentrations for arsenic, lead, chromium, iron and manganese. The south monitoring well (sample 2) indicates a contamination to a lesser degree. Chemical parameters of arsenic, lead, zinc and manganese were found to be in concentrations above the objective recommendations.

10.3.4 CONCLUSION

Based on the data available to date, local groundwater contamination of the unconfined aquifer appears to be occurring. Chemical analyses of samples from the monitoring wells on the site show levels of some constituents above the recommended drinking water standards.

Contaminant flow appears to be with the groundwater gradient in a northeasterly direction. The extent of the affected aquifer area is unknown, but dilution, dispersion and attenuation should decrease contaminant concentrations with distance from the site. Since no residences exist within the near vicinity of the site, the possible effect of the contamination on drinking water supplies is low.

10.3.5 RECOMMENDATIONS

a) Both monitoring wells should be resampled in late spring when infiltration is high.

b) Sampling of water wells within 1.5 km of the site is recommended.

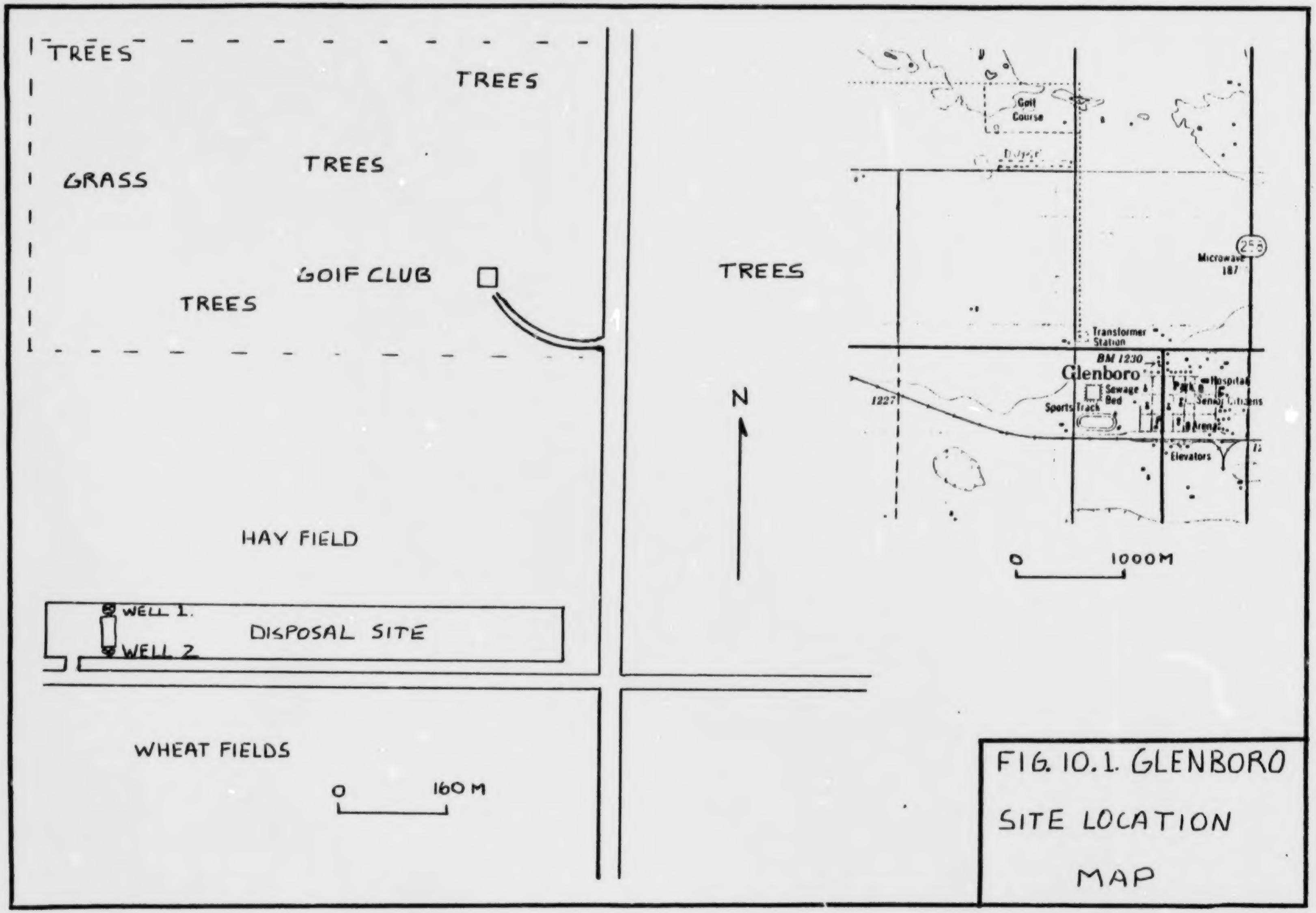

TREES
TREES
GRASS
TREES
GOIF CLUB
TREES
TREES
N
HAY FIELD
WELL 1.
WELL 2
DISPOSAL SITE
WHEAT FIELDS
0
160 M
Golf Course
256
Microwave 187
Transformer Station
BM 1230
Glenboro
Sewage & Bed
Sports Track
Park
Hospital
Senior Citizens
Arena
Elevators
1227
0
1000M

FIG. 10.1. GLENBORO SITE LOCATION MAP

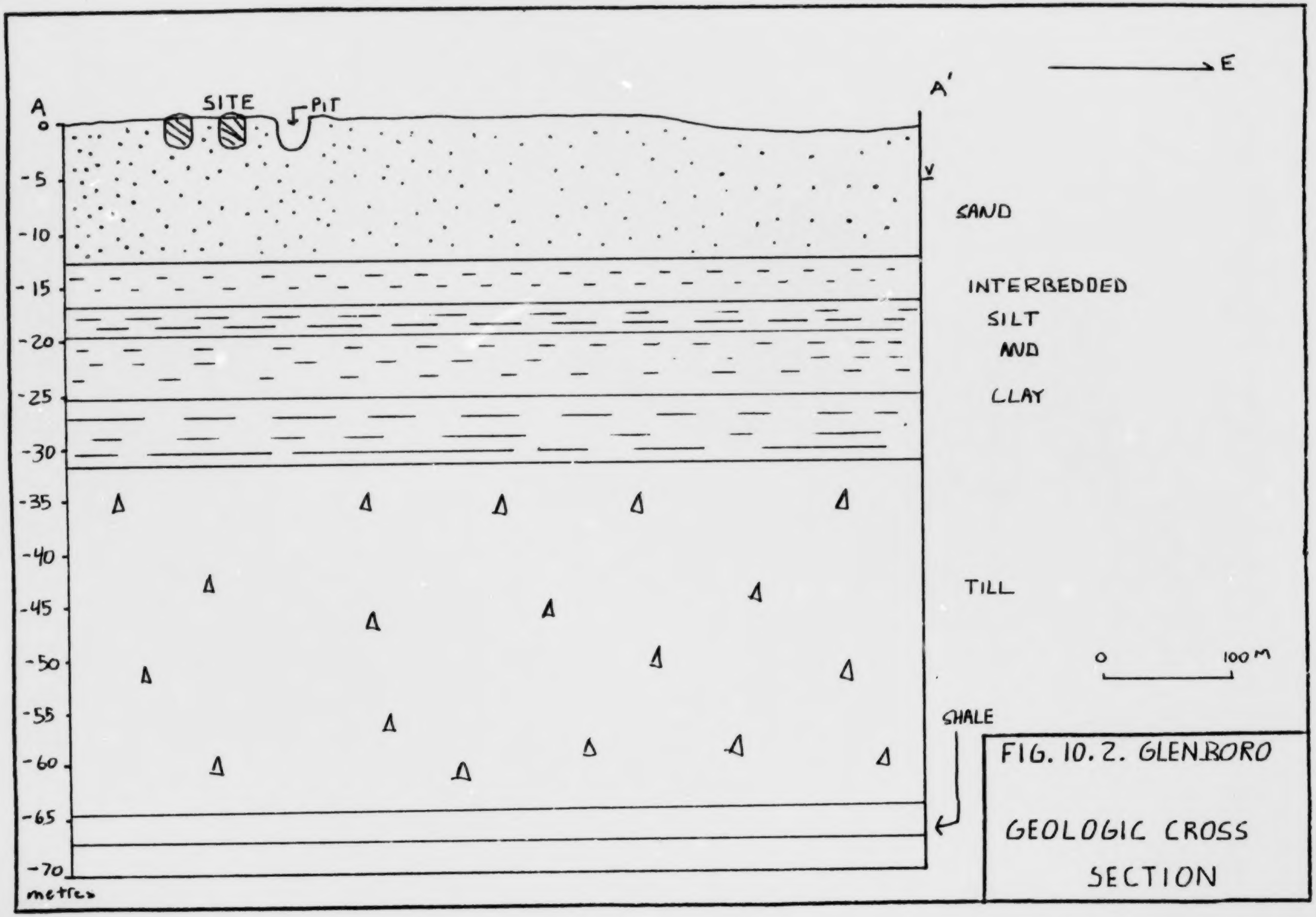

A
A'
SITE
PIT
E
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
-70
metres
SAND
INTERBEDDED
SILT
AND
CLAY
TILL
SHALE
0
100 M

FIG. 10.2. GLENBORO GEOLOGIC CROSS SECTION

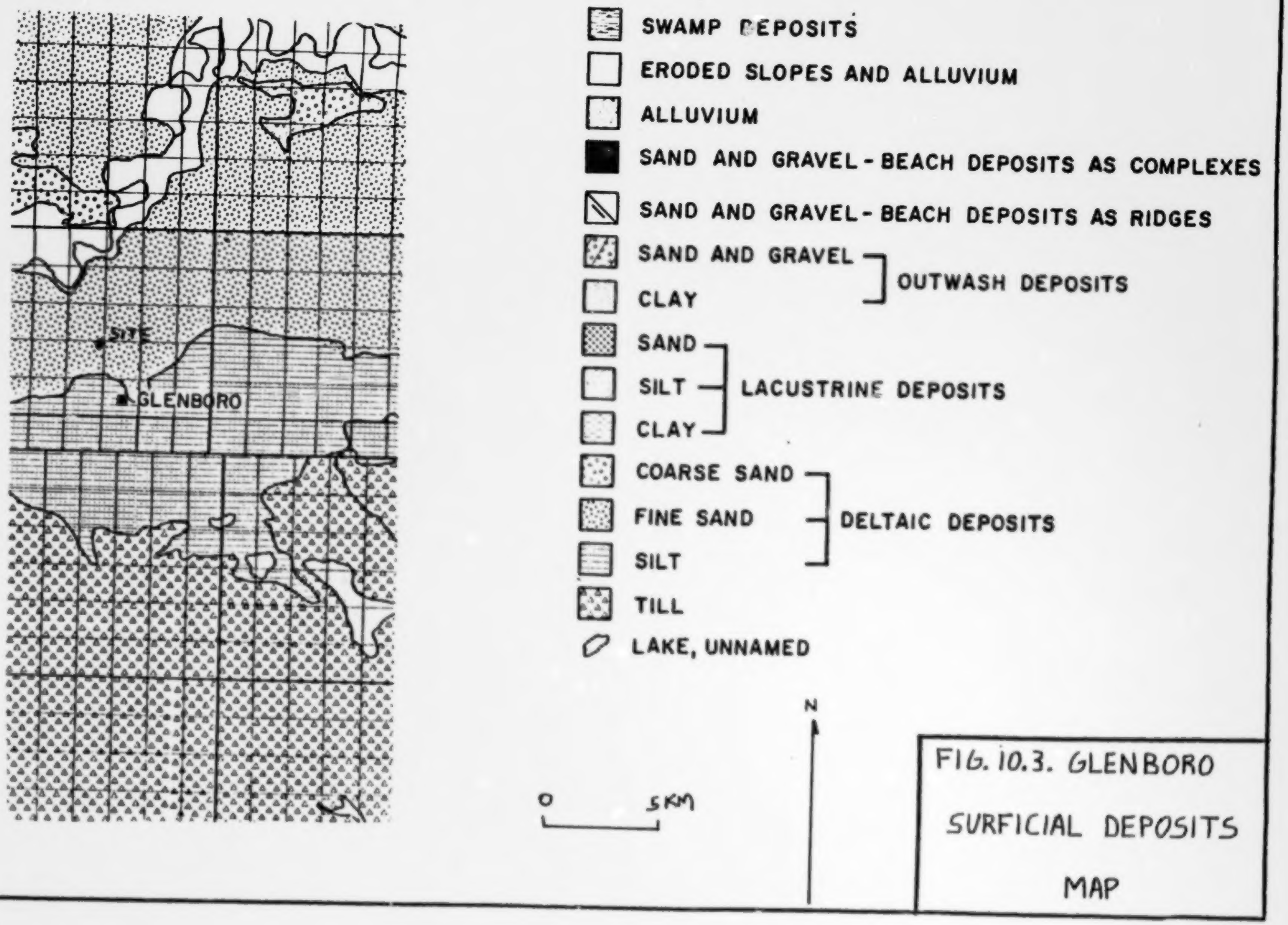

SITE
GLENBORO
SWAMP DEPOSITS
ERODED SLOPES AND ALLUVIUM
ALLUVIUM
SAND AND GRAVEL - BEACH DEPOSITS AS COMPLEXES
SAND AND GRAVEL - BEACH DEPOSITS AS RIDGES
SAND AND GRAVEL
CLAY
OUTWASH DEPOSITS
SAND
SILT
CLAY
LACUSTRINE DEPOSITS
COARSE SAND
FINE SAND
SILT
DELTAIC DEPOSITS
TILL
LAKE, UNNAMED
N
0
5KM

FIG. 10.3. GLENBORO SURFICIAL DEPOSITS MAP

TABLE 10.1. GLENBORO

Site Number	1	2		
Parameters				
Conductivity umho/cm	735	672		
Residue Total mg/L	10100	5660		
Residue Filt mg/L	370	320		
Residue Non-Filt mg/L	9740	5340		
pH units	7.45	7.35		
Alkal. Total ($CaCO_3$) mg/L	472	418		
Alkalinity (HCO_3) mg/L	576	510.		
Alkalinity (CO_3) mg/L	0	0		
Alkalinity (OH) mg/L	0	0		
As (Ext.) mg/L	.200	.047		
Cd (Ext.) mg/L	.002	<.001		
Cu (Ext.) mg/L	.14	.03		
Pb (Ext.) mg/L	1.17	.024		
Ni (Ext.) mg/L	.11	.019		
Zn (Ext.) mg/L	.42	.08		
Cr (Total) mg/L	.262	.026		
Calcium (Ext.) mg/L	594	166		
Magnesium (Ext.) mg/L	134	50.2		
Hardness ($CaCO_3$) mg/L	2036	622		
Manganese (Ext.) mg/L	7.45	1.87		
Iron (Ext.) mg/L	45.5	13.6		
Potassium (Ext.) mg/L	6.	16.50		
Sodium (Ext.) mg/L	22.	19.4		
COD mg/L	320	200		
T.O.C. mg/L	95.	110		
Turbidity NTU	3100.	1250		
CN (Free) mg/L	<.02	<.02		
Kieldnal, Total-N mg/L	10.4	5.5		
NH_3-N (Sol.) mg/L	.19	.34		
NO_3-NO_2-N (Diss.) mg/L	1.70	.05		
P-Total mg/L	5.1	1.7		
Chloride (Sol.) mg/L	23	7		
Sulphate (Sol.) mg/L	73.8	26		
Fecal Coliform /100 mL	-	-		
Total Coliform /100 mL	-	-		

TABLE 10.2 GLENBORO SOIL LOGS

WELL #	DEPTH (METRES)	DESCRIPTION
1	0 - 3.1	fine to med. yellow sand
	3.1 - 4	silt
	4 - 6.8	sand yellow S.A.A.
	6.8 - 15	silty fine grained sand (grey)
	15 - 17.5	clay, soft, grey, silty
2	0 - 3	fine to med. yellow sand
	3 - 6	fine sand, silty, grey
	6 - 7	grey, silty, clay

CHAPTER - ELEVEN -

HARTNEY

R.M. OF CAMERON

NW 9-6-23W

11 HARTNEY WASTE DISPOSAL SITE

11.1 RECONNAISSANCE DATA

11.1.1 LOCATION

The Town of Hartney, Manitoba, is located in the R.M. Of Cameron, approximately 240 Km west-southwest of Winnipeg along P.T.H. 21. The existing waste disposal site is located 500 metres southwest of the town off a gravel road on Section NW 9-6-23W.

11.1.2 PHYSIOGRAPHY

The area consists of flat open prairie with gently rolling hills. The site encroaches the channel of a seasonal creek. This creek drains into the nearby Souris River.

Vegetation consists of agricultural fields on the flatlands and marsh grasses in the creek channel.

11.1.3 BACKGROUND

This waste disposal site has been operating in its current location for more then 15 years. In 1977, this site was registered with the Province as an existing waste disposl ground. In 1978, a new site was registered; however, upon inspection it was found that the old site is still in use.

This site currently serves about 500 people. Primarily municiple waste from the Town of Hartney and household was from rural areas is disposed at this site. The town water supply is derived from a deep well. The area is also served by a 2 cell sewage lagoon which discharges into the Souris River downstream of the town area.

11.1.4 SITE CONDITION

During the site inpsection on September 18, 1984, several observations were made. The site is located directly off a Section Road 500 m southwest of the town. The site is approximately 20 m by 50 m with an active area of 10 m by 7 m.

The waste disposal method employed is open, above grade deposition. Waste is currently being pushed over the waste mound, burned and mixed with fill periodically. The waste mound has begun to fill in the creek channel.

Although a sign indicates a seperate chemical container area, containers were seen mixed with the waste and burned. There is no separate metallic waste area and the site is not fenced. Waste has been strewn throughout the creek bed. In general, the site is in poor condition. The location of this site is inadequate due to its close proximity to the creek. The nearest residents are located in town, over 800 m away.

11.1.5 DRILLING AND SAMPLING

A drilling and monitoring program was not undertaken at this site.

11.2 GEOLOGIC DATA

11.2.1 GEOLOGIC SETTING

The area is located on the lacustrine sediments of ancient glacial Lake Souris. The sediments consist of interbedded sand, silt and clay overlying glacial till (see Figure 11.2).

11.2.2 BEDROCK

The bedrock in this area consists of shale from the Cretaceous period. The shale is hard with water bearing fracture zones.

11.2.3 OVERBURDEN

Two distinct sediment units compose about 30 metres of overburden overlying bedrock. The lower unit consists of dense, calcareous till, about 27 metres thick. The upper few metres appear to be mainly silts with interbedded layers of fine sands and clays (see Figure 11.3).

11.2.4 GEOHYDROLOGY

The main aquifer in this area consists of extensive fracture zones in the bedrock. The thick layer of impermeable till confines this aquifer at depth.

Lenses of sand and gravel in the till unit form small confined aquifers. Several residential wells are set into this unit on sections surrounding the site.

11.3 ENVRIONMENTAL INTERPRETATION AND ASSESSMENT

11.3.1 LEACHATE HYDROLOGY

Leachate is produced by infiltration of precipitation into the burried waste. The downward migration of leachate is limited due to the impermeable till at several metres depths. Consequently, groundwater and drinking water contamination by this site is not likely.

The burried waste encroaches part of the adjacent channel; therefore, it is likely that some contamination of the channel and its alluvium occurs periodically. Runoff from the site can also enter the creek water directly, causing surface water contamination from pesticides and leachates.

11.3.2 METHANE

Based on the amount of waste deposited, an estimated 5 million cubic metres of methane gas may be produced each year at this site. Since waste is burned, the actual quantity of methane gas generated will only be a fraction of the estimate. Methane migration should be limited since waste is deposited above grade; gas will likely vent directly into the atmosphere.

11.3.3 WATER QUALITY

In general, groundwater quality in the sand aquifers in the area is good. The ability of the sediments to attenuate contaminants is also quite good, based on the clay percentage of the soil.

11.3.4 CONCLUSION

This disposal site is still active and the proposed site has not been placed into operation. The location of the present site is not acceptable. With the burried waste encroaching the creek channel, contamination of the creek bed and the underlying alluvium is likely. Strewn debris also litters the channel around the site.

11.3.5 RECOMMENDATIONS

a) Closure of the site is recommended as the current site is full.

b) A general cleanup of the area around the site and application of a final fill cover is desireable.

c) The proposed site should be implemented.

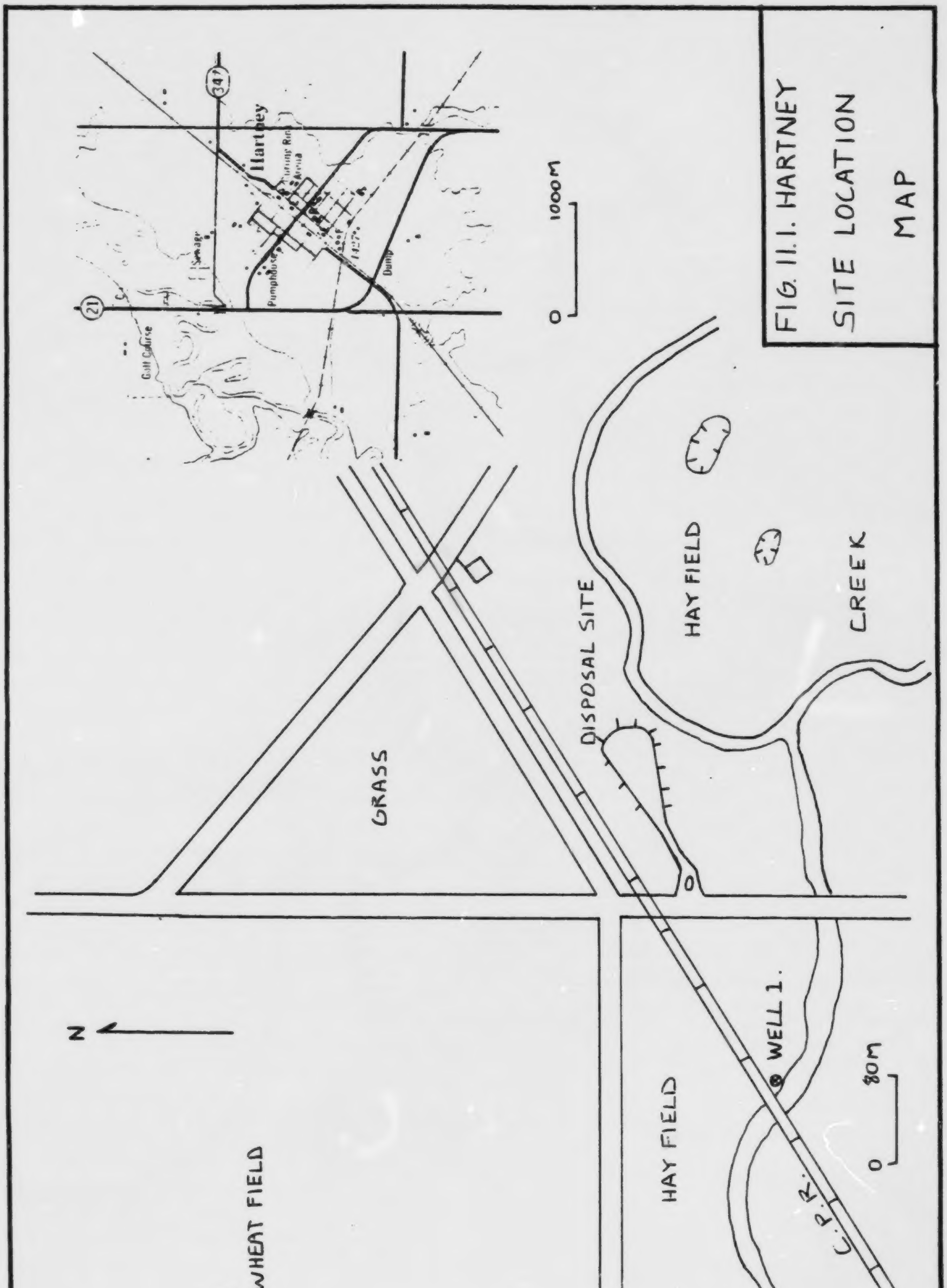

Hartney
21
347
Golf Course
Sewage
Pumphouse
Curling Rink
Arena
Dump
0
1000M
WHEAT FIELD
GRASS
DISPOSAL SITE
HAY FIELD
HAY FIELD
CREEK
WELL 1.
C.P.R.
N
0
80M

FIG. II.1. HARTNEY SITE LOCATION MAP

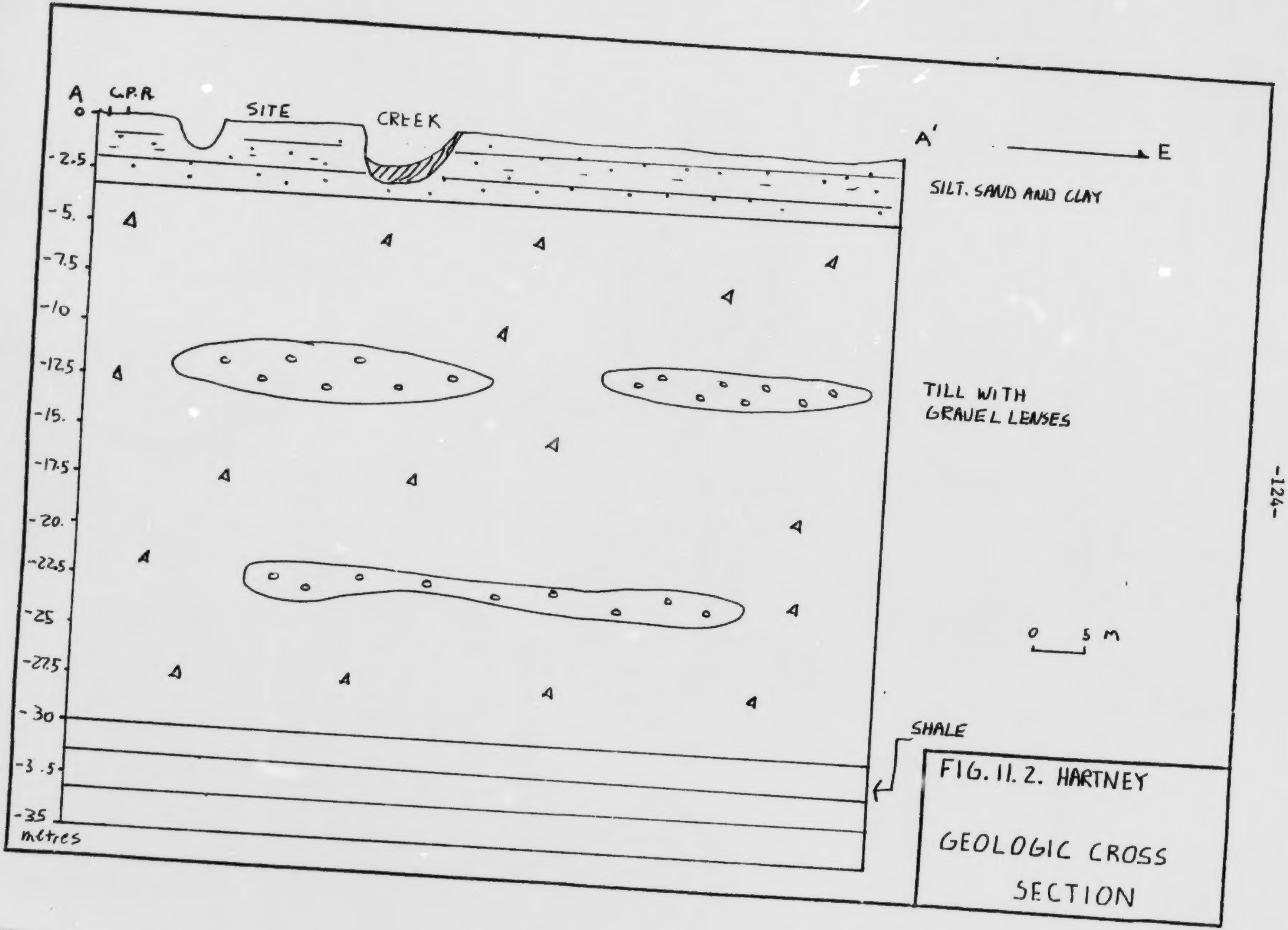

A
A'
C.P.R.
SITE
CREEK
E
SILT. SAND AND CLAY
TILL WITH GRAVEL LENSES
SHALE
0 5 M
0
-2.5
-5.
-7.5
-10
-12.5
-15.
-17.5
-20.
-22.5
-25
-27.5
-30
-3.5
-35
metres

FIG. II. 2. HARTNEY

GEOLOGIC CROSS SECTION

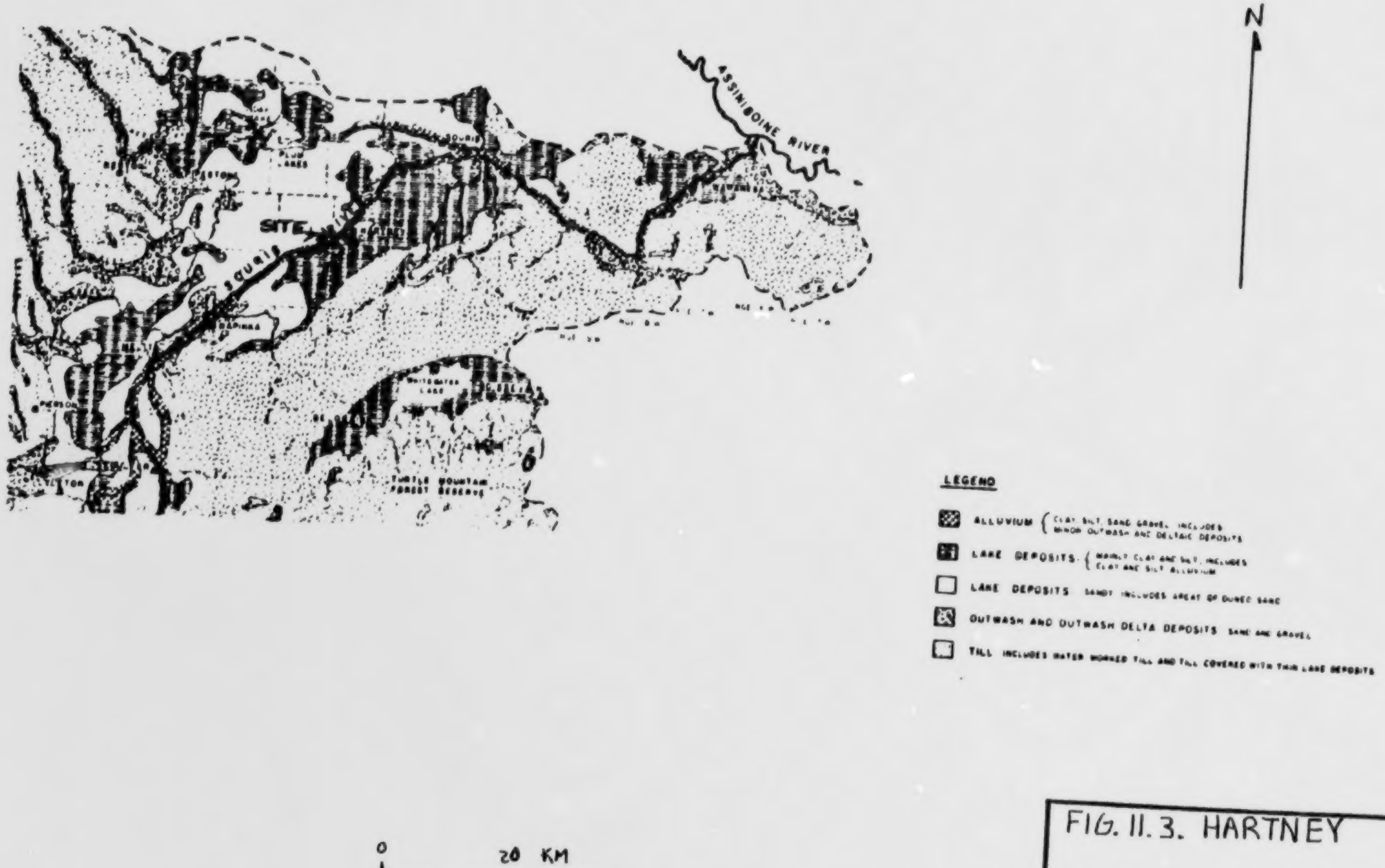

N
ASSINIBOINE RIVER
SOURIS
SITE
TURTLE MOUNTAIN FOREST RESERVE
LEGEND
ALLUVIUM { CLAY SILT SAND GRAVEL INCLUDES MINOR OUTWASH AND DELTAIC DEPOSITS
LAKE DEPOSITS { MAINLY CLAY AND SILT, INCLUDES CLAY AND SILT ALLUVIUM
LAKE DEPOSITS SANDY INCLUDES AREAS OF DUNED SAND
OUTWASH AND OUTWASH DELTA DEPOSITS SAND AND GRAVEL
TILL INCLUDES WATER WORKED TILL AND TILL COVERED WITH THIN LAKE DEPOSITS
0
20 KM

FIG. II. 3. HARTNEY

SURFICIAL DEPOSITS

MAP

CHAPTER - TWELVE -

KILLARNEY

(Inactive)

R.M. OF TURTLE MOUNTAIN

NE 3-3-17W

12 KILLARNEY WASTE DISPOSAL SITE

12.1 RECONNAISSANCE DATA

12.1.1 LOCATION

The Town of Killarney, Manitoba, is located in the R.M. of Turtle Mountain, 180 km southwest of Winnipeg off P.T.H. 18. The inactive waste disposal site is located on the northwest corner of the town on Section NE 3-3-17W (see Figure 12.1).

12.1.2 PHYSIOGRAPHY

The area is characterized by a flat prairie with occasional depressions filled by sloughs and stagnant ponds.

An essentially flat topograpy surrounds the elevated landfill site. A minor depression just south of the site forms a seasonal slough with grass vegetation. The adjacent land use consists of open fields.

12.1.3 BACKGROUND

This waste disposal site is inactive. Primarily municipal waste from the Town of Killarney and household waste from surrounding rural areas is buried at this site. Records show that this site served approximately 2000 people for over 25 years. Approximately 1 km to the south lies Killarney Lake which serves as the water supply for the town.

The area is served by a 3 cell sewage lagoon which discharges into Whitemud Creek.

12.1.4 SITE CONDITIONS

During the site inspection on September 12, 1984, several observations were made. The site is located approximately 250 m north of the newest development in the northwest corner of the town. The site has been covered and seeded, and no evidence of waste was seen.

Six PVC monitoring wells were previously installed by the Province along the south side of the disposal site.

12.1 GEOLOGIC DATA

12.2.1 GEOLOGIC SETTING

The site is situated on the extensive till plains of the Southwestern Uplands. A blanket of dense calcareous till covers the underlying bedrock. Although this unit is of low permeability, saturated lenses of sand and gravel form local and confined aquifers (see Figure 12.2 and Figure 12.3).

12.2.2 BEDROCK

The depth to bedrock is estimated at about 30 metres. A light grey siltstone and shale from the Cretaceous Period forms the bedrock. Saturated fracture zones are common.

12.2.3 OVERBURDEN

Overburden consists of approximately 30 metres of glacial till. Small lenses of sand and gravel may exist at various depths in this area.

12.2.4 GEOHYDROLOGY

Two types of aquifers exist in this area. Fractured zones in the bedrock form aquifers confined under the thick impermeable till unit. Sand and gravel lenses form small confined aquifers in the till. Unconfined sand and gravel aquifers are not reported.

12.3 ENVIRONMENTAL INTERPRETATION AND ASSESSMENT

12.3.1 LEACHATE HYDROLOGY

Leachate generation at this site occurs by infiltration of precipitation through the fill material and the buried waste. In general, runoff does not contribute to this process since the shape of the elevated landfill diverts flow off the site.

Due to the low permeability of the subsurface, leachate migration should be limited to several meters beneath the site. Consequently, the potential for groundwater contamination is low.

12.3.2 METHANE

Based on the amount of waste deposited, an estimated 13 million cubic metres of methane gas may be produced per year. Since the site has been closed for several years, actual production per year should be a fraction of the above estimate.

Migration of methane gas from the site should be less than 50 metres, based on the permeability of the sediments. No building exist within this migration belt.

12.3.3 WATER QUALITY

Water quality analysis of the sample taken from one monitoring well on the site appears to show signs of contamination. Chemical parameter levels of sulphate, nitrate, manganese, chromium, and iron were found to be higher than the recommended concentrations.

The natural alkalinity levels of the water beneath the site has also been effected. Leachate contamination may be causing a decrease in pH level in the vicinity of the buried waste (see Table 12.1).

12.3.4 CONCLUSION

It appears that water quality beneath the site is affected by leachate from the buried waste. This contamination should be localized with little influence on sand lense aquifers at depth. Accordingly, the possibility of well contamination away from the immediate site area is low.

12.3.5 RECOMMENDATIONS

a) Wells should be sampled within 500 metres of the site.

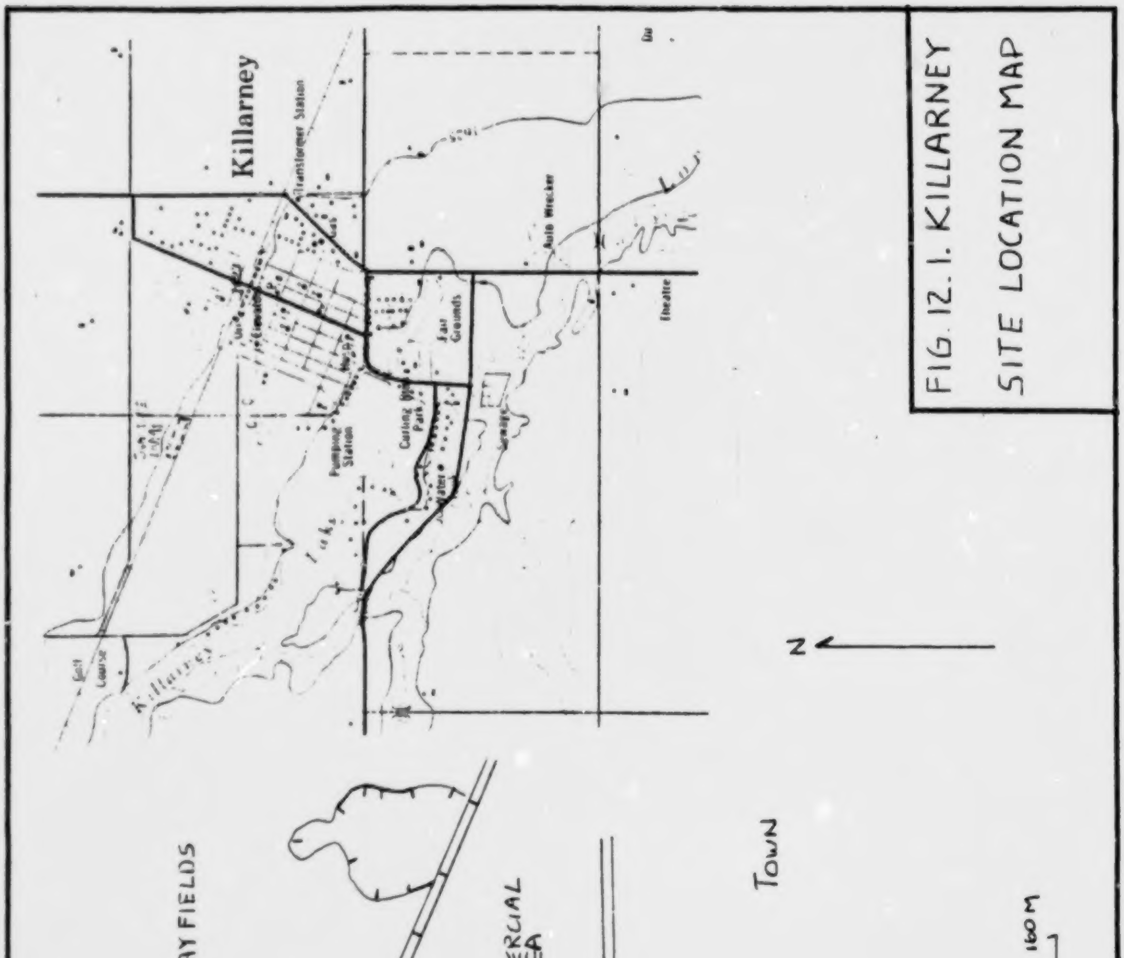

DISPOSAL SITE
WELLS
1
2
3
4
5
6
HAY FIELDS
TOWN
HAYFIELDS
TOWN
LAKE KILLARNEY
C.P.R.
HAYFIELDS
COMMERCIAL AREA
TOWN
0
100M
N
Killarney
Transformer Station
Pumping Station
Park
Fair Grounds
Auto Wrecker
Theatre
Golf Course
Killarney Lake

FIG. 12.1. KILLARNEY SITE LOCATION MAP

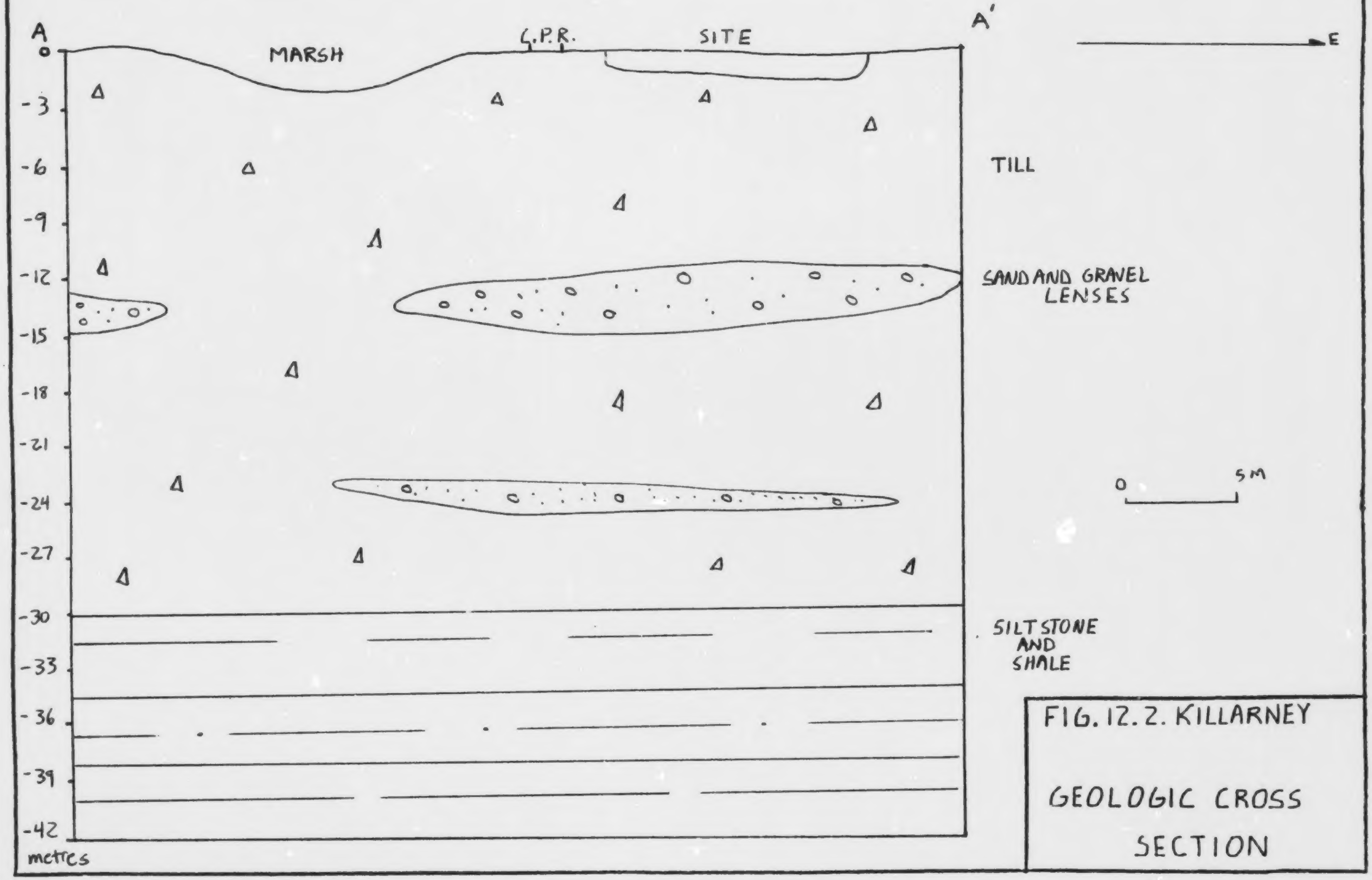

A
A'
MARSH
G.P.R.
SITE
E
TILL
SAND AND GRAVEL LENSES
SILTSTONE AND SHALE
0
5M
0
-3
-6
-9
-12
-15
-18
-21
-24
-27
-30
-33
-36
-39
-42
metres

FIG. 12.2. KILLARNEY

GEOLOGIC CROSS SECTION

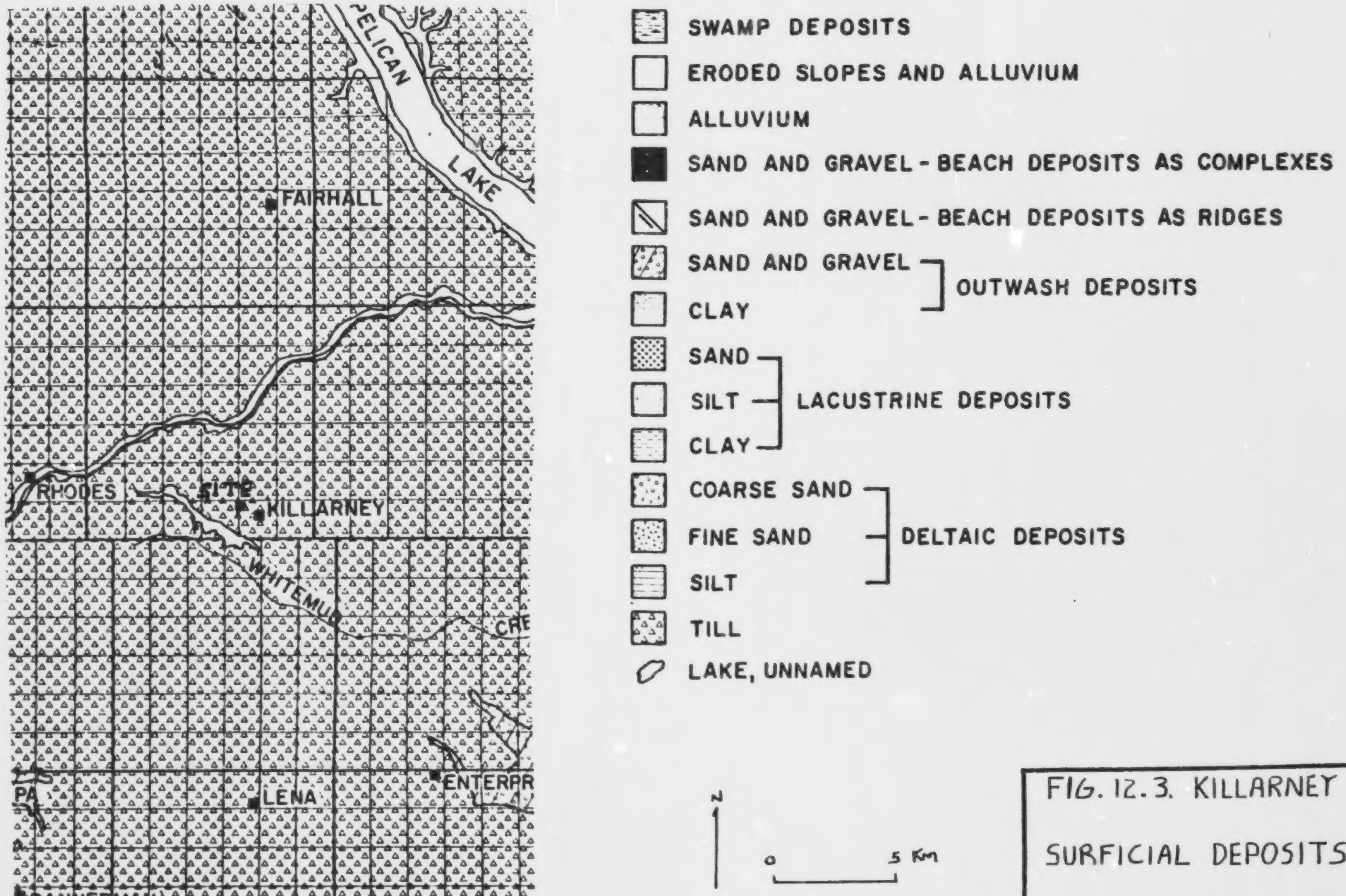

PELICAN LAKE
FAIRHALL
RHODES
SITE
KILLARNEY
WHITEMUD CRE
PA
LENA
ENTERPR
BANNERMAN
SWAMP DEPOSITS
ERODED SLOPES AND ALLUVIUM
ALLUVIUM
SAND AND GRAVEL - BEACH DEPOSITS AS COMPLEXES
SAND AND GRAVEL - BEACH DEPOSITS AS RIDGES
SAND AND GRAVEL
CLAY
OUTWASH DEPOSITS
SAND
SILT
CLAY
LACUSTRINE DEPOSITS
COARSE SAND
FINE SAND
SILT
DELTAIC DEPOSITS
TILL
LAKE, UNNAMED
N
0
5 Km

FIG. 12.3. KILLARNEY SURFICIAL DEPOSITS MAP

TABLE 12.1. KILLARNEY

Site Number	1			
Parameters				
Conductivity umho/cm	6160			
Residue Total mg/L	6390			
Residue Filt mg/L	5900			
Residue Non-Filt mg/L	500			
pH units	7.00			
Alkal. Total ($CaCO_3$) mg/L	888			
Alkalinity (HCO_3) mg/L	1080			
Alkalinity (CO_3) mg/L	0			
Alkalinity (OH) mg/L	0			
As (Ext.) mg/L	.008			
Cd (Ext.) mg/L	< .001			
Cu (Ext.) mg/L	.07			
Pb (Ext.) mg/L	< .005			
Ni (Ext.) mg/L	.008			
Zn (Ext.) mg/L	.11			
Cr (Total) mg/L	.082			
Calcium (Ext.) mg/L	620			
Magnesium (Ext.) mg/L	496			
Hardness ($CaCO_3$) mg/L	3580			
Manganese (Ext.) mg/L	.40			
Iron (Ext.) mg/L	6.25			
Potassium (Ext.) mg/L	15.5			
Sodium (Ext.) mg/L	763			
COD mg/L	99			
T.O.C. mg/L	41.5			
Turbidity NTU	300			
CN (Free) mg/L	< .02			
Kjeldnal, Total-N mg/L	2.3			
NH_3-N (Sol.) mg/L	.14			
NO_3-NO_2-N (Diss.) mg/L	12.6			
P-Total mg/L	.40			
Chloride (Sol.) mg/L	170			
Sulphate (Sol.) mg/L	2840			
Fecal Coliform /100 mL	-			
Total Coliform /100 mL	-			

CHAPTER - THIRTEEN -

MINITONAS

R.M. OF MINITONAS

SW 17-36-25W

13 MINITONAS WASTE DISPOSAL SITE

13.1 RECONNAISSANCE DATA

13.1.1 LOCATION

The Town of Minitonas, Manitoba, is located in the R.M. of Minitonas, approximately 360 km northwest of Winnipeg along P.R. 366. The waste disposal site is located 500 m east of the town on Section SW 17-36-25W (see Figure 13.1).

13.1.2 PHYSIOGRAPHY

The landscape in this area is nearly flat with a gentle dip in topography to the north. Drainage around the site is along road ditches, north and west towards the East Faval River.

The vegetation consists of grassland and extensive cottonwoods. The site is mainly open with bushes and trees along the site borders.

13.1.3 BACKGROUND

This site has been operating on its current location for over a decade. In 1977, the site was registered with the Province as an existing waste disposal site. Current records show this site serves about 800 people. Primarily municipal waste from the Town of Minitonas and household waste from surrounding rural areas is deposited at this site. The waste disposal method used is above grade deposition and burning.

The public treated water supply is derived from a well and serves 500 people. The area is also served by a two cell sewage lagoon located on the west side of town and discharges into the Faval River.

13.1.4 SITE CONDITIONS

During the site inspection on September 20, 1984, several observations were made. The site is located directly off a Section Road 500 m east of the town and covers an area of approximately 200 m by 100 m with an active area of 100 m by 10 m. The waste disposal method is burning, mixing with fill and above grade mound deposition. The current waste mound is approximately 1.5 m high.

Access to the site is through a gate, as the site is fenced in. The site has a pile of bulky metallic wastes mixed with chemical pesticide containers. A berm does not exist. Overall the site location is good but a summer cabin is located only 100 m southwest of the site.

13.1.5 DRILLING AND SAMPLING

No drilling program was undertaken at this site.

Water samples from two nearby wells were collected on December 6, 1984. The water quality is discussed in Section 13.3.3. and the results summarized in Table 13.1.

13.2 GEOLOGIC DATA

13.2.1 GEOLOGIC SETTING

The area is located on the glacial till plain which overlies bedrock in most of the Swan River Basin. The till is generally a calcareous, clayey gravel with variable permeabilities. Lenses of clay, sand and gravel and large boulders are common (see Figure 13.2).

13.2.1 BEDROCK

Shale and sandstone from the Cretaceous Period forms the bedrock at approximately 38 m depth.

13.2.2 OVERBURDEN

About 38 m of highly calcareous glacial till overlies bedrock in this area. Discontinuous layers of sand, gravel and boulders are common (see Figure 13.3).

13.2.3 GEOHYDROLOGY

In general, this till is semi-permeable and saturated with lenses of sand and gravel forming small local aquifers. The water table in the till is 1 to 3 meters below grade depending on location.

Unconsolidated quartz sandstone forms the bedrock aquifer in this area. Most wells in this area are set into bedrock. Dugouts and some shallow wells draw water from the till unit.

13.3 ENVIRONMENTAL INTERPRETATION AND ASSESSMENT

13.3.1 LEACHATE HYDROLOGY

Leachate is generated at this site by precipitation infiltrating the buried waste and migrating into the till subsurface. Since the water table and possibly lenses of sand and gravel are located near the surface, localized groundwater contamination appears likely. Dilution, dispersion and attenuation should decrease contaminant concentrations with distance from the site.

The bedrock aquifer is not likely affected by the site since the 38 m of semi-permeable till should allow little recharge to occur.

13.3.2 METHANE

Based on the amount of waste deposited at this site, an estimated 4 million cubic metres of methane gas may be produced per year. Since the waste is burned before burial, the actual quantity of methane gas generated will only be a fraction of the estimate.

Migration of methane gas should be limited since waste is deposited above grade. Methane gas most likely vents directly into the atmosphere with little subsurface migration.

13.3.3 WATER QUALITY

The chemical analysis results of the samples taken from the area vary widely in quality (see Table 13.1).

Sample 2, taken from the nearby farm located north of the site shows good quality water. Sample 1, taken from a summer cabin located 100 metres southwest of the site shows very poor quality water.

Field conductivity, residue total, arsenic and manganese are found in concentrations above objective levels. Parameters such as chloride, sulphate, nitrate, turbidity, iron, hardness and zinc are found in concentrations above the maximum recommended levels.

13.3.4 CONCLUSION

Local contamination of shallow aquifers in the vicinity of the site appears likely. This may affect water quality in dugouts and shallow wells near the site. Most wells in this area are set into the bedrock aquifer at depth. Contamination of drinking water from this source is not possible near the site in shallow wells.

Water samples from two wells in the area were collected. The sample from the nearby cabin was of poor water quality and showed elevated levels of contaminants and bacteria. It is unknown whether the well is set into the shallow or deep aquifer, or if the well is being contaminated by the waste disposal site.

13.3.4 RECOMMENDATIONS

a) The wells in the area should be resampled and well depth determined.

b) Shallow and deep monitoring wells should be installed around the site.

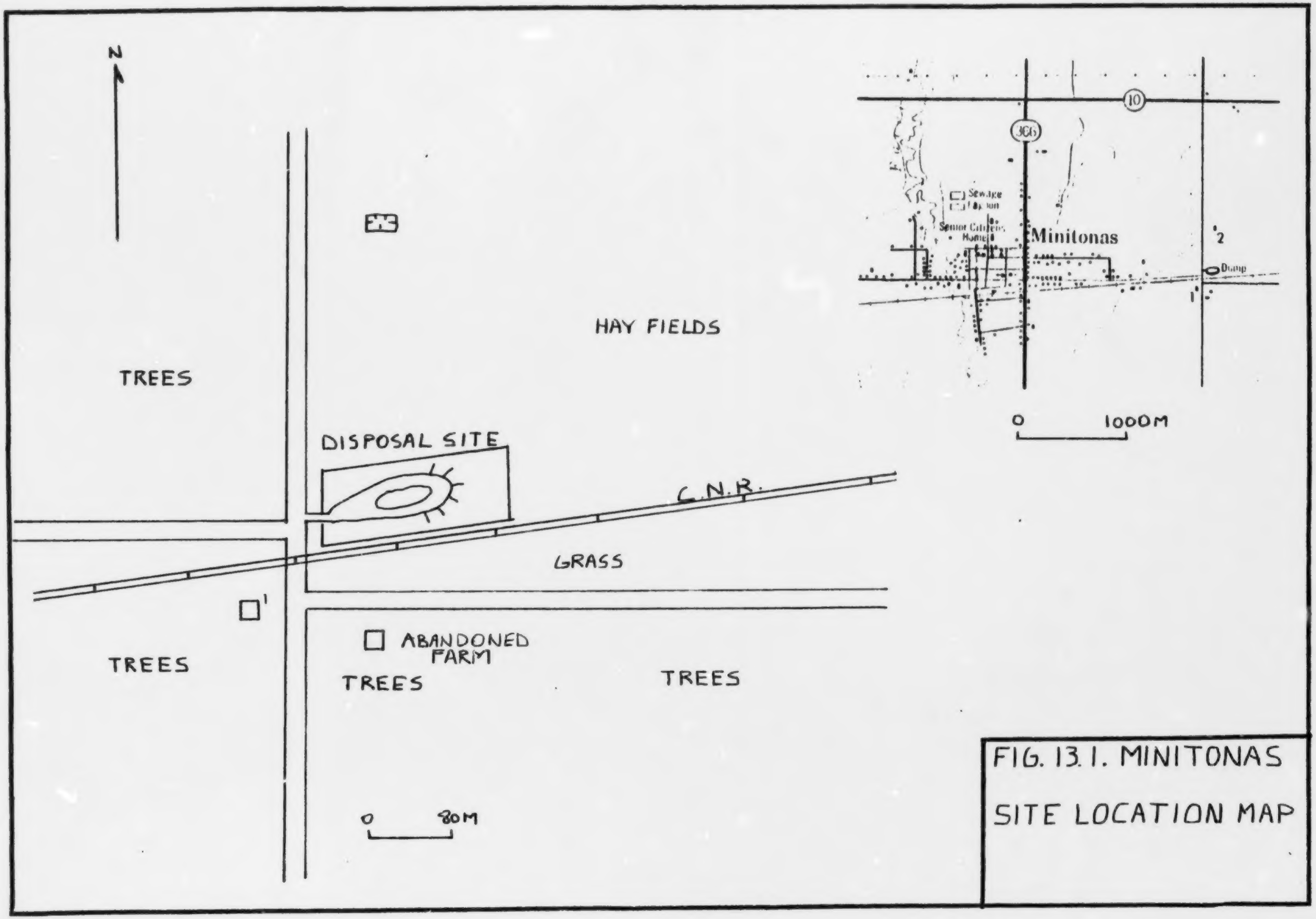

N
TREES
HAY FIELDS
DISPOSAL SITE
C.N.R.
GRASS
1
ABANDONED FARM
TREES
TREES
TREES
0 80M
10
366
Sewage Lagoon
Senior Citizens Home
Minitonas
2
Dump
1
0 1000M

FIG. 13.1. MINITONAS SITE LOCATION MAP

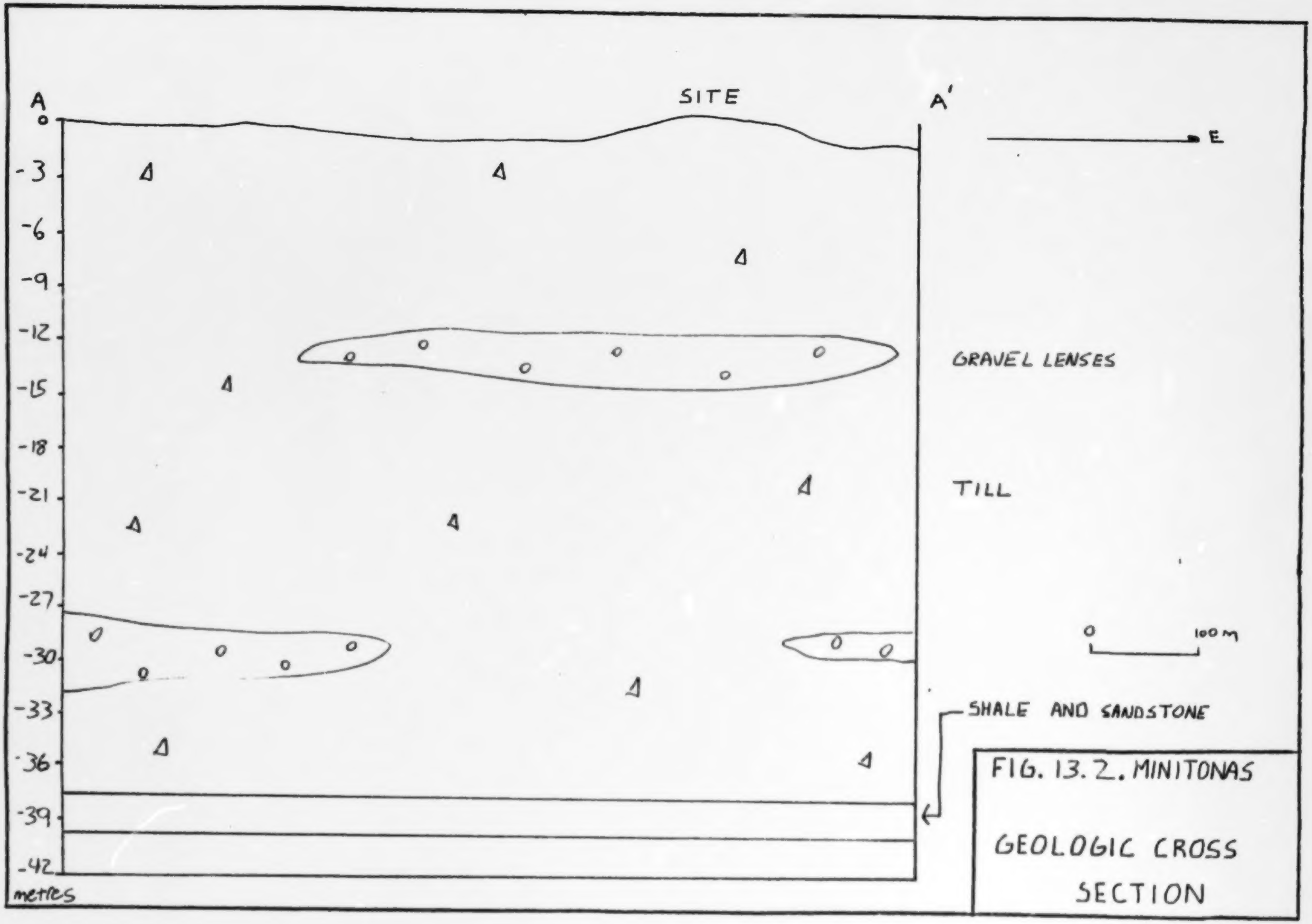

A
A'
SITE
E
0
-3
-6
-9
-12
-15
-18
-21
-24
-27
-30
-33
-36
-39
-42
metres
GRAVEL LENSES
TILL
0
100 m
SHALE AND SANDSTONE

FIG. 13.2. MINITONAS

GEOLOGIC CROSS SECTION

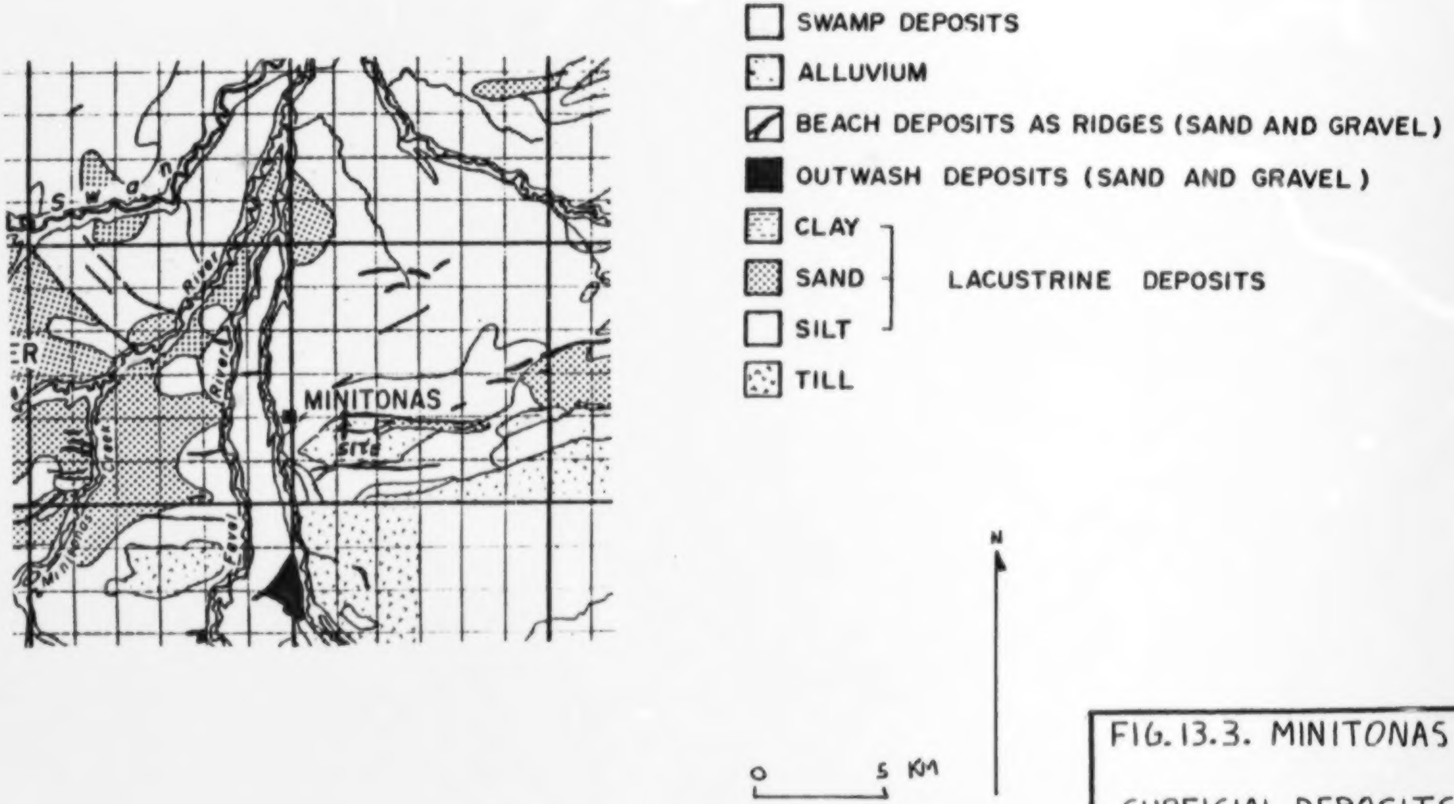

SWAMP DEPOSITS
ALLUVIUM
BEACH DEPOSITS AS RIDGES (SAND AND GRAVEL)
OUTWASH DEPOSITS (SAND AND GRAVEL)
CLAY
SAND
SILT
LACUSTRINE DEPOSITS
TILL
MINITONAS
SITE
S W a n
River
River
Favel
Minitonas Creek
R
N
0
5 KM

FIG. 13.3. MINITONAS SURFICIAL DEPOSITS MAP

TABLE 13.1. MINITONAS

Site Number	1	2		
Parameters				
Conductivity umho/cm	4190	1550		
Residue Total mg/L	3360	1050		
Residue Filt mg/L	3220	1050		
Residue Non-Filt mg/L	140	5		
pH units	7.55	7.35		
Alkal. Total ($CaCO_3$) mg/L	748	526		
Alkalinity (HCO_3) mg/L	913	642		
Alkalinity (CO_3) mg/L	0	0		
Alkalinity (OH) mg/L	0	0		
As (Ext.) mg/L	.029	<.001		
Cd (Ext.) mg/L	<.001	<.001		
Cu (Ext.) mg/L	.05	.02		
Pb (Ext.) mg/L	<.005	<.005		
Ni (Ext.) mg/L	.015	.011		
Zn (Ext.) mg/L	1.32	0.33		
Cr (Total) mg/L	<.005	<.005		
Calcium (Ext.) mg/L	383	138		
Magnesium (Ext.) mg/L	157	70.0		
Hardness ($CaCO_3$) mg/L	1600	632		
Manganese (Ext.) mg/L	.32	.26		
Iron (Ext.) mg/L	8.63	.56		
Potassium (Ext.) mg/L	155	54.0		
Sodium (Ext.) mg/L	292	57.4		
COD mg/L	110	25		
T.O.C. mg/L	96.5	14.5		
Turbidity NTU	100	2.		
CN (Free) mg/L	<.02	<.02		
Kieldnal, Total-N mg/L	2.8	.80		
NH_3-N (Sol.) mg/L	.09	.07		
NO_3-NO_2-N (Diss.) mg/L	94	3.00		
P-Total mg/L	4.5	<.01		
Chloride (Sol.) mg/L	390	40		
Sulphate (Sol.) mg/L	1030	28		
Fecal Coliform /100 mL	<1	<1		
Total Coliform /100 mL	10	<1		

CHAPTER - FOURTEEN -

MORDEN

R.M. OF STANLEY

NE 10-3-6W

14 MORDEN WASTE DISPOSAL SITE

14.1 RECONNAISSANCE DATA

14.1.1 LOCATION

The Town of Morden, Manitoba, is loated in the R.M. of Stanley approximately 83 Km southwest of Winnipeg, along P.T.H. 3. The waste disposal site is located about 4.8 Km west of the town and 400 metres north of highway 3 on Section NE 10-3-6W, (see Figure 14.1, 14.2).

14.1.2 PHYSIOGRAPHY

The area consists of an open beach ridge topography on the eastern slopes of the Manitoba Escarpment. The relief is lightly rolling with a moderate northeasterly dip towards the Manitoba Lowlands.

Agricultural fields and hay land dominate the vegetation with areas of cotton woods interspersed in the landscape. To the east, south and west, the site is surrounded by hay land, and a field to the north.

Regional drainage consists of channels incised into the escarpment, while local drainage appears absent. Depressions around the site form sloughs with stagnant water.

14.1.3 BACKGROUND

This waste disposal site has been operating on its current location for 9 years. In 1977, the site was registered with the Province as an existing waste disposal site. Current records show that this site serves approximately 5000 people. Primarily municiple waste from the town and household waste from surrounding rural areas are deposited at this site. A trench system is used to dispose of common wastes, while bulky metallic wastes are collected on the surface in piles.

The town's treated water supply is derived from Lake Minnewasta located 4.4. Km southeast of the disposal site. Private water supplies of residents located in this area is from shallow wells.

14.1.4 SITE CONDITIONS

During the site inspection on September 13, 1984, several observations were made. Access to the site is from an all weather road 200 m west, onto the fenced site area. The site is approximately 160 m by 160 m. The active area is a large trench 60 m by 20 m by 5 m deep. Waste is deposited on the surface by the trench, burned, pushed in and buried when the trench is full. There is a separate area for metallic waste, and for agricultural chemical containers. The site appears to be well maintained and supervised daily.

A gravel pit and kiln are located just east of the site along the access road. A gas pipeline passes 20 m from the southwest corner of the site, and two residences are located within 500 m of the site.

14.1.5 DRILLING AND SAMPLING

Three monitoring wells were installed on November 20, 1984. The wells number 1 and 2 serve as methane probes while well 3 is designed exclusively for water sampling. All three are located on Figure 14.2, and soil logs are summarized in Table 14.2.

Three water samples were taken on January 04, 1985 from well 3 and two nearby residential wells. The sites are numbered 3, 4 and 5. The results are discussed in Section 14.3.3 and summarized in Table 14.1.

14.2 GEOLOGIC DATA

14.2.1 GEOLOGIC SETTING

During the last ice age, the shores of glacial Lake Agassiz formed beach ridges of sand and gravel which cover the underlying till topography. Depressions and channel cuts in the till form local, shallow, unconfined aquifers in the overlying sands and gravel (see Figure 14.3).

14.2.2 BEDROCK

Dark grey shale from the Cretaceous Period was encountered during drilling at a depth of about 10 metres. The shale is very soft, dense and appears to be of very low permeability.

14.2.3 OVERBURDEN

Two units of overburden overly bedrock beneath the site. The lower unit consists of 8 to 9 metres of grey and brown dense tills. Stringers and small lenses of sand or gravel are often confined in this unit. Sand and gravel form the 1 to 2 metre thick surficial unit (see Figure 14.4).

14.2.4 GEOHYDROLOGY

The surficial sands and gravels form local unconfined aquifers in this area. In areas where subsurface flow drains down the escarpment, no unconfined aquifers exist. Since the aquifers are shallow and limited in extend, the amount of water available is limited. Recharge occurs by direct infiltration of precipitation into the aquifer.

On the active site area, the surficial sand and gravel unit is dry, but precipitation from the site area recharges surrounding aquifers.

14.3 ENVIRONMENTAL INTERPRETATION AND ASSESSMENT

14.3.1 LEACHATE HYDROLOGY

Leachate may be generated by the waste buried at this site. The trenches used for disposal are dug through the sand and gravel into the low permeability till below. Accumulation of precipitation and waste creates a leachate pool in the pit which may at times overflow into the sand unit and migrate to nearby aquifers.

An aquifer which appears to exist immediately north of the site may be affected by leachate overflow.

14.3.2 METHANE

Based on the amount of waste deposited at this site, an estimated 10 million cubic metres of methane gas may be produced per year. Since the majority of waste is burned before burial the actual quantity of methane gas generated should be only a fraction of the above estimate.

The migration distance of any gas generated should be limited to 50 metres based on the permeability of the sediments. No buildings exist in this migration belt.

Two methane probes were installed at this site. Methane readings taken on January 04, 1985 were zero.

14.3.3 WATER QUALITY

Chemical analysis of the three water samples indicate varying degrees of water quality.

The sample taken from monitoring well 3, located on the site, appears to indicate only minor contamination is taking place. Slightly higher than normal lead, arsenic, sulphate and COD levels were found. The water quality of this well can be considered good.

The sample taken from well 4, a residential well, appears to indicate no contamination from the site is occurring. The high nitrate levels found in this water is suspected to be naturally occurring or caused by local contamination such as the private septic facility. Overall the water at this location can be considered fair in quality.

The sample taken from well 5, a farm residence appears to indicate limited contamination from the landfill site is occurring. However, very high levels of sulphate, residue totals, sodium and nitrate were found. These levels are suspected to be caused by feedlot or septic contamination occurring in the immediate area of the well location. Overall this water can be considered poor in quality.

14.3.4 CONCLUSION

Since the surficial sand and gravel deposit forms local aquifers around the site, this area is pollution sensitive. During periods of high groundwater levels, leachates from the clay till trenches may overflow into the overlying gravel unit and contaminate adjacent shallow aquifers. Local contamination from septic systems, feedlots, and other sources is also suspected.

Water quality in the monitoring well installed on the site is good. Thus, it appears that aquifer contamination by the landfill is minimal. One residential well sampled shows poor water quality and from the type of contaminants present, local well contamination is suspected.

14.3.5 RECOMMENDATIONS

a) Possible sources of local well contamination should be identified.

b) Re-sampling of the wells, including the two methane probes is recommended in late spring when infiltration is high.

c) An additional monitoring well in the shallow aquifer immediately north of the site is desireable.

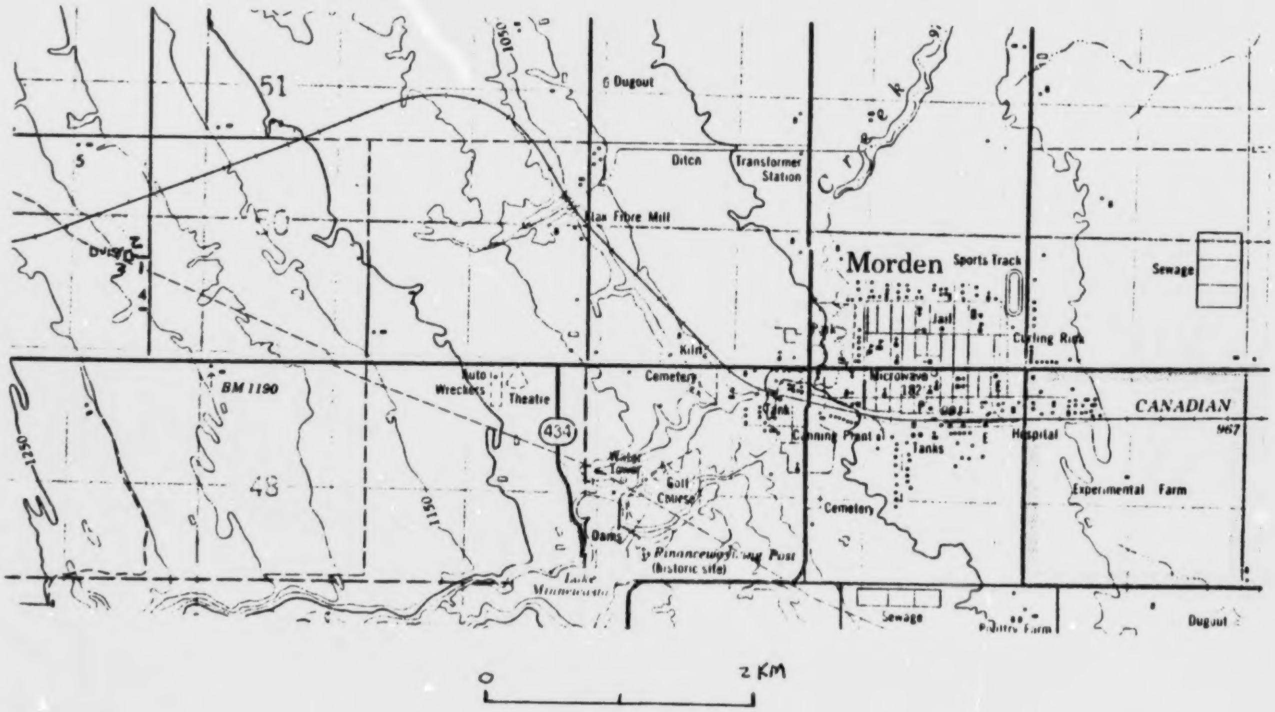

51
50
48
5
Dugout
1050
Dugout
Ditch
Transformer Station
Creek
Flax Fibre Mill
Morden
Sports Track
Jail
Curling Rink
Sewage
Kiln
Cemetery
Auto Wreckers
Theatre
BM 1190
434
Microwave
382
Tank
Canning Plant
Tanks
Hospital
CANADIAN
967
Water Tower
Golf Course
Dams
Pinancewaywining Post
(historic site)
Lake Minnewasta
Cemetery
Experimental Farm
Sewage
Poultry Farm
Dugout
1150
1250
0
2 KM

FIG.141. MORDEN SITE LOCATION MAP

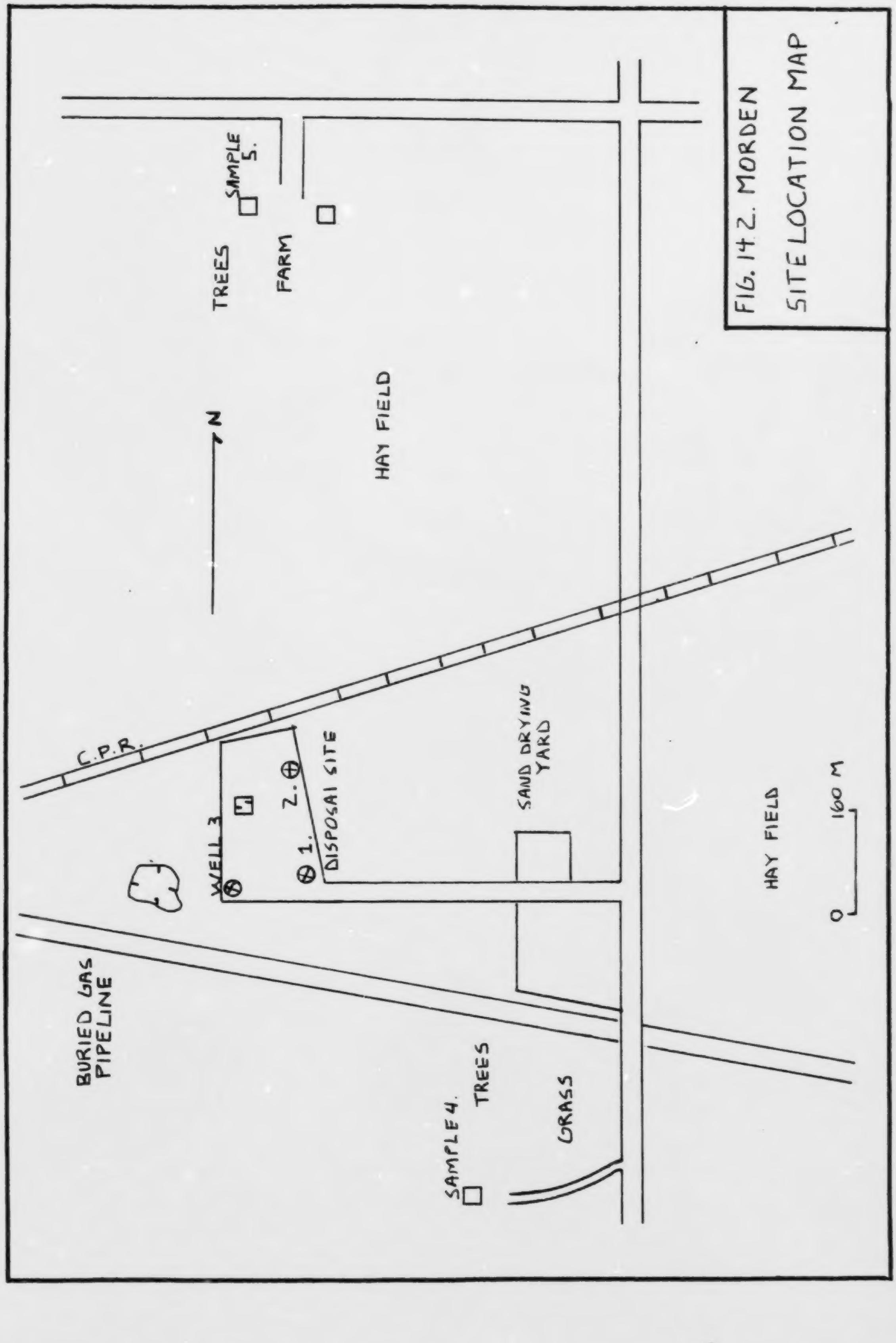

SAMPLE 5.
TREES
FARM
N
HAY FIELD
C.P.R.
WELL 3
1.
2.
DISPOSAL SITE
SAND DRYING YARD
HAY FIELD
0
160 M
BURIED GAS PIPELINE
TREES
SAMPLE 4.
GRASS

FIG. 14.2. MORDEN SITE LOCATION MAP

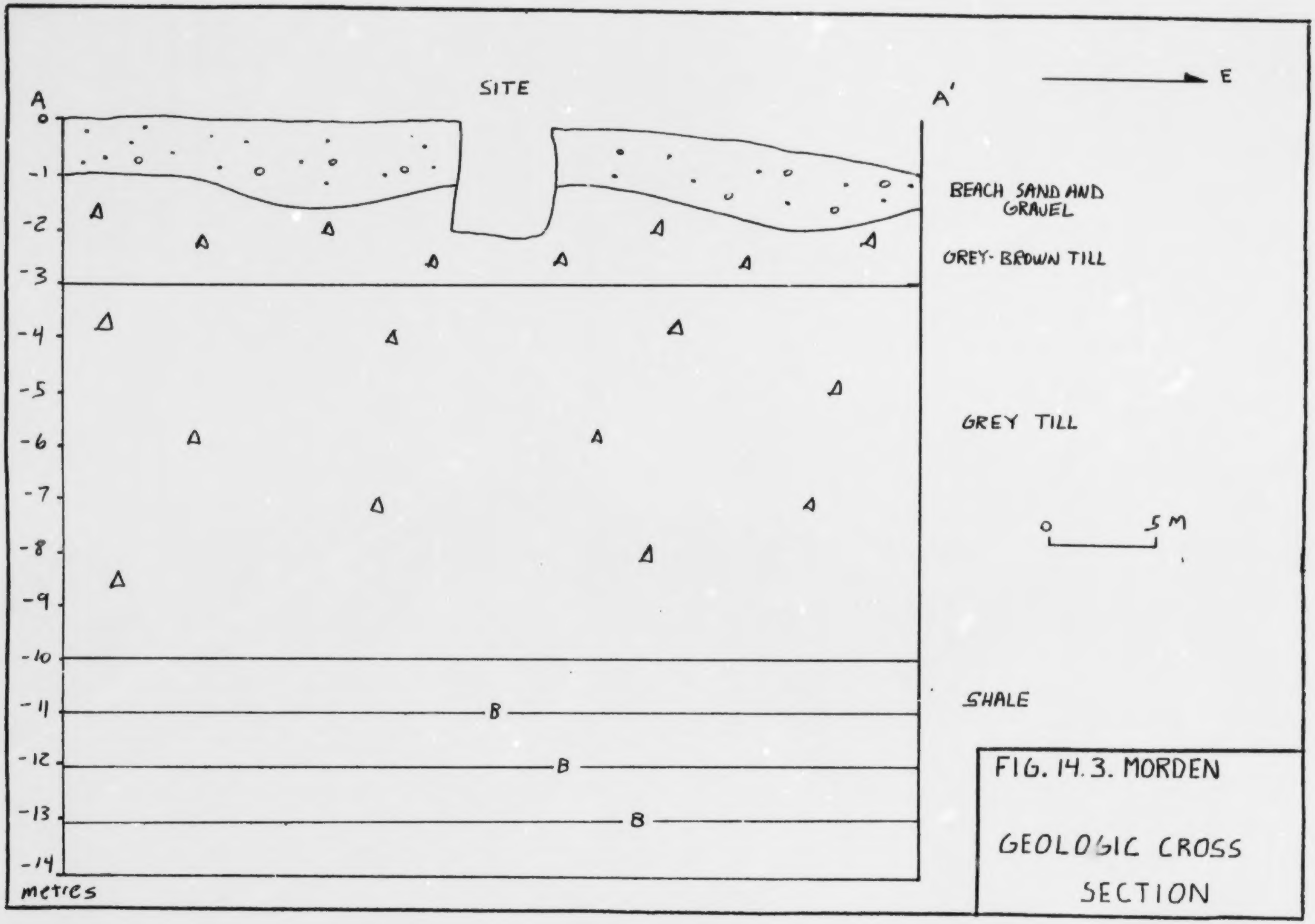

E
SITE
A
A'
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
-11
-12
-13
-14
metres
B
B
B
BEACH SAND AND GRAVEL
GREY-BROWN TILL
GREY TILL
SHALE
0
5 M

FIG. 14.3. MORDEN

GEOLOGIC CROSS SECTION

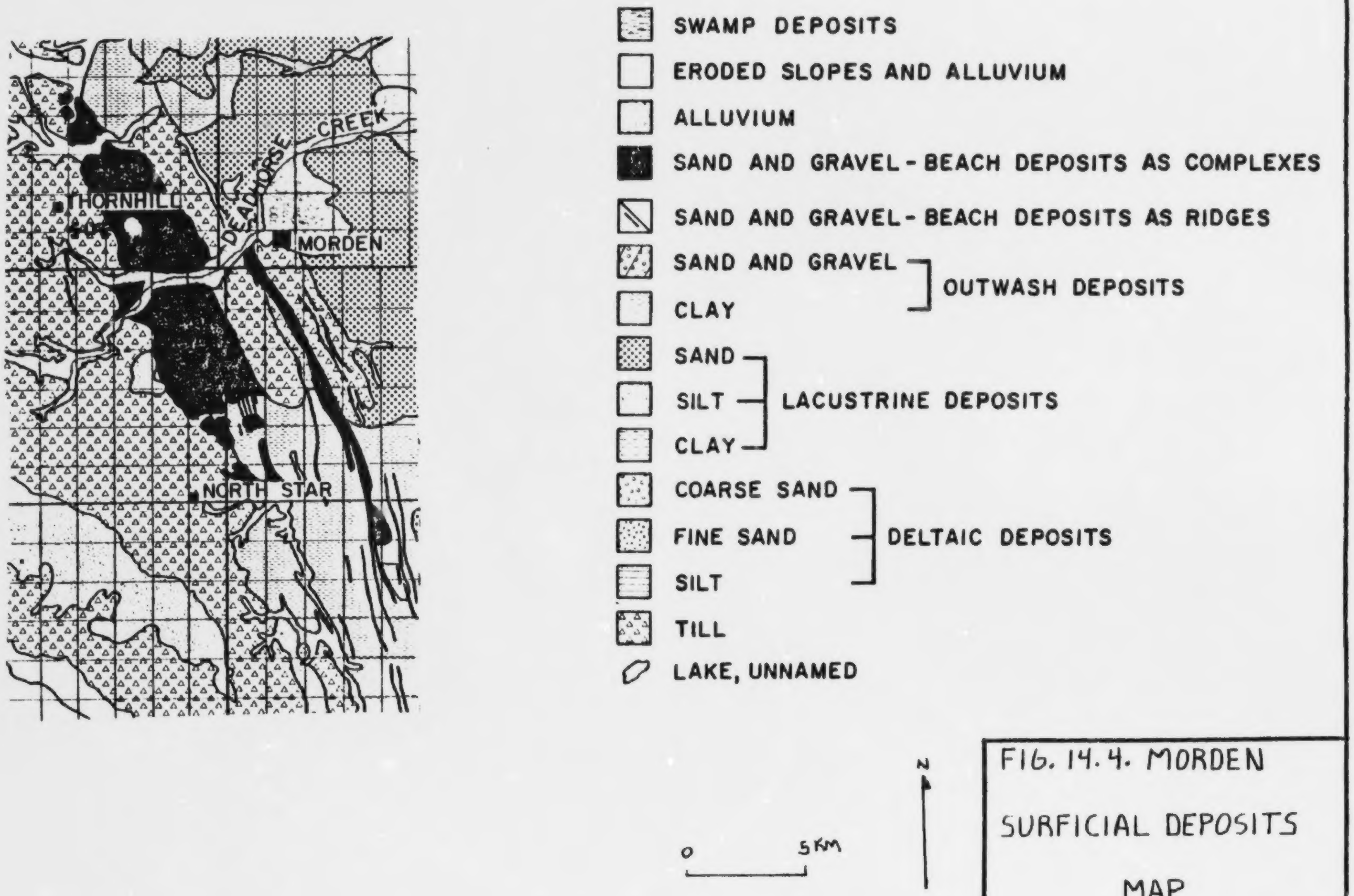

THORNHILL
DEADHORSE CREEK
MORDEN
NORTH STAR
▨ SWAMP DEPOSITS
☐ ERODED SLOPES AND ALLUVIUM
☐ ALLUVIUM
■ SAND AND GRAVEL - BEACH DEPOSITS AS COMPLEXES
▨ SAND AND GRAVEL - BEACH DEPOSITS AS RIDGES
▨ SAND AND GRAVEL
☐ CLAY
OUTWASH DEPOSITS
▨ SAND
☐ SILT
☐ CLAY
LACUSTRINE DEPOSITS
▨ COARSE SAND
▨ FINE SAND
▨ SILT
DELTAIC DEPOSITS
▨ TILL
LAKE, UNNAMED
0
5KM
N

FIG. 14.4. MORDEN SURFICIAL DEPOSITS MAP

TABLE 14.1. MORDEN

Site Number	3	4	5	
Parameters				
Conductivity umho/cm	1060	866	2350	
Residue Total mg/L	870	580	2040	
Residue Filt mg/L	790	580	2040	
Residue Non-Filt mg/L	82	<5.	<5.	
pH units	7.85	7.50	7.75	
Alkal. Total ($CaCO_3$) mg/L	314	310	272	
Alkalinity (HCO_3) mg/L	383	378	332	
Alkalinity (CO_3) mg/L	0	0	0	
Alkalinity (OH) mg/L	0	0	0	
As (Ext.) mg/L	.004	<.001	<.001	
Cd (Ext.) mg/L	<.001	<.001	<.001	
Cu (Ext.) mg/L	.01	.06	.06	
Pb (Ext.) mg/L	.009	<.005	<.005	
Ni (Ext.) mg/L	<.005	<.005	<.005	
Zn (Ext.) mg/L	.03	.42	1.05	
Cr (Total) mg/L	<.005	<.005	<.005	
Calcium (Ext.) mg/L	128.	102	265	
Magnesium (Ext.) mg/L	58.0	49.6	130	
Hardness ($CaCO_3$) mg/L	559	459	1198	
Manganese (Ext.) mg/L	.57	<.02	.04	
Iron (Ext.) mg/L	1.17	.06	.28	
Potassium (Ext.) mg/L	5.00	<5.00	<5.00	
Sodium (Ext.) mg/L	35.	18.8	116.	
COD mg/L	78	<2.	4	
T.O.C. mg/L	31.5	27.0	31.0	
Turbidity NTU	15	.85	.50	
CN (Free) mg/L	<.02	<.02	<.02	
Kjeldhal, Total-N mg/L	.60	.30	.70	
NH_3-N (Sol.) mg/L	.03	.02	.04	
NO_3-NO_2-N (Diss.) mg/L	.02	11	11.4	
P-Total mg/L	.09	<.01	.02	
Chloride (Sol.) mg/L	34	20	49	
Sulphate (Sol.) mg/L	245	125	1020	
Fecal Coliform /100 mL	-	-	-	
Total Coliform /100 mL	-	-		

TABLE 14.2 MORDEN SOIL LOGS

WELL #	DEPTH (METRES)	DESCRIPTION
1	0 - 1.1	sand, gravel
	1.1 - 2.7	hard green grey till
	2.7 - 2.9	brown sand
	2.9 - 10	dense dark grey till
	10 - 13	millwood shale
2	0 - 1.75	sand, gravel
	1.75 - 1.90	brown till
	1.90 - 4.0	grey till
3	0 - 1.1	sand, gravel
	1.1 - 3	grey clay mixed with sand
	3 - 3.2	sandy grey till

CHAPTER - FIFTEEN -

MUNRO FARM SUPPLIES

WESTBOURNE

SE 35-14-9W

15 MUNRO FARM SUPPLIES LTD. AGRICULTURAL CHEMICAL CONTAINER DISPOSAL SITE

15.1 RECONNAISSANCE DATA

15.1.1 LOCATION

Munro Farm Supplies Ltd. is located in the Town of Westbourne, Manitoba, approximately 88 kilometres northwest of Winnipeg along P.T.H. 16. The agricultural chemical container disposal site is located 95 metres south of Fifth Street on Section SE 35-14-9W (see Figure 15.1).

15.1.2 PHYSIOGRAPHY

The area is located in the Lake Agassiz basin of the Manitoba Lowlands. The topography shows next to no relief other than drainage channels. The Whitemud River, incised 5 metres into its alluvial channel bed meanders through the area towards Lake Manitoba. Small, seasonal drainage streamlets form back-cutting channels into the sourrounding basin plain.

The terrain is mainly open prairie with trees supported only along channels and around farms. A shallow depression of a drainage streamlet passes immediately west of the site.

15.1.3 BACKGROUND

The site is owned and operated by Munro Farm Supplies Ltd. of Westbourne, Manitoba. It is designated exclusively for the flushing, storage, crushing and disposal of agricultural chemical containers.

It is located on private property on the grass flats on the town's industrial park.

The town water supply is derived from an intake well just upstream of the site, and distributed through the town area. The source aquifer is shallow alluvial deposits of the Whitemud River supplying all 113 residents. Sewage disposal in the town consists of private septic systems. A brine aquifer is reported at a depth of about 50 metres; therefore, private potable water wells do not exist around the site.

Buildings, as outlined in Figure 15.1, consist of a bulk storage for liquid fertilizer 102 metres east of the site, and a house 90 metres north on Fifth Avenue.

15.1.4 SITE CONDITIONS

A number of observations were made during a site inspection on September 11, 1984. Access to the site is on a mud trail across grass flats from the bulk fertilizer facility.

This small site consists of a 20 x 20 metre area surrounded by open grass flats. The west site borders on a shallow wooded depression which is part of a runoff channel draining into the Whitemud River.

Signs clearly mark the access trail and disposal area. A steel mesh container holds plastic and paper articles before burning. Ground storage area for 400-800 containers is estimated for the existing area. A large flushing tank trailer is located on the site for convenience. Although no fencing exists, the area appears well kept.

15.1.5 DRILLING AND SAMPLING

Drilling was not undertaken at the site.

Water samples for pesticide analysis were taken from Whitemud River upstream and downstream of the mouth of the runoff channel draining the area. Sample locations are indicated on the site map, Figure 15.1. The results appear to indicate no contamination by pesticides is occurring.

15.2 GEOLOGIC DATA

15.2.1 GEOLOGIC SETTING

The site area is located on Lake Agassiz basin clays (Figure 15.2.). These clays overly previously deposited glacial clay till which in turn overlies bedrock. The Whitemud River which is incised below the surrounding grade has reworked the sediments in its meander loops to form alluvium and expose the glacial till locally.

Sand and gravel lenses do not exist in the basin clays and only as small pockets in the clay till. As a result, the sediments are very low in overall permeability. Rainfall is absorbed by the topsoil and transpires, with the excess running through streamlets into the Whitemud River.

15.2.2 BEDROCK

Fractured shale bedrock from the Jurassic Period underlies the site at a depth of about 45 metres below grade.

15.2.3 OVERBURDEN

Bedrock is overlain by about 40 metres of clay till with some layers of silt and small pockets of sand and gravel. Glacial basin clays form the upper 3 to 5 metres of overburden (see Figure 15.3).

15.2.4 GEOHYDROLOGY

The only major aquifer reported in the area consists of the saturated, fractured bedrock. However, water quality is generally very poor and naturally high in salt levels.

The overburden does not support any aquifers beneath the site area. Due to the impermeability of these sediments, the overburden forms a confining unit for the bedrock aquifer and no recharge occurs in this area.

15.3 ENVIRONMENTAL INTERPRETATION AND ASSESSMENT

15.3.1 LEACHATE HYDROLOGY

Leachates from the site consists exclusively of agricultutal herbicides and pesticides. The quantity of leachates exposed are very small since the chemical containers are flushed and the residue collected.

Those chemicals that reach the ground are absorbed by the upper one metre of clay beneath the site. During periods of snowmelt and high rainfall, minute amounts of chemical may wash with the local runoff into the seasonal streamlet next to the site.

Overall, leachate generation from normal site operation should not affect the surrounding environment beyond the site limits.

15.3.2. METHANE

Methane generation does not exist at this site since only agricultural chemical residues and containers are stored here.

15.3.3 WATER QUALITY

It appears that no aquifers in the area will be affected by this site and water quality of the Whitemud River should not be effected.

15.3.4 CONCLUSION

The environmental impact of this site is very low. Local aquifers and groundwater sources are not affected. Surface waters and the town water supply taken from the Whitemud River are not affected, also. Overall, this site is suitably located and operated.

Leachate quantities from the site are very small since the chemical containers are rinsed and residue is collected in a storage tank. However, in the event of a leak in the residue tank, quantities of chemical could enter the streamlet and eventually the Whitemud River.

15.3.5 RECOMMENDATIONS

a) The construction of a small berm around the site is recommended to contain chemicals in the event of a spill from the residue tank.

b) A fence is desirable to establish site boundaries and to keep children from the town away from the chemicals.

c) Metal containers should be stacked in a way to limit residue leakage through the open bungs.

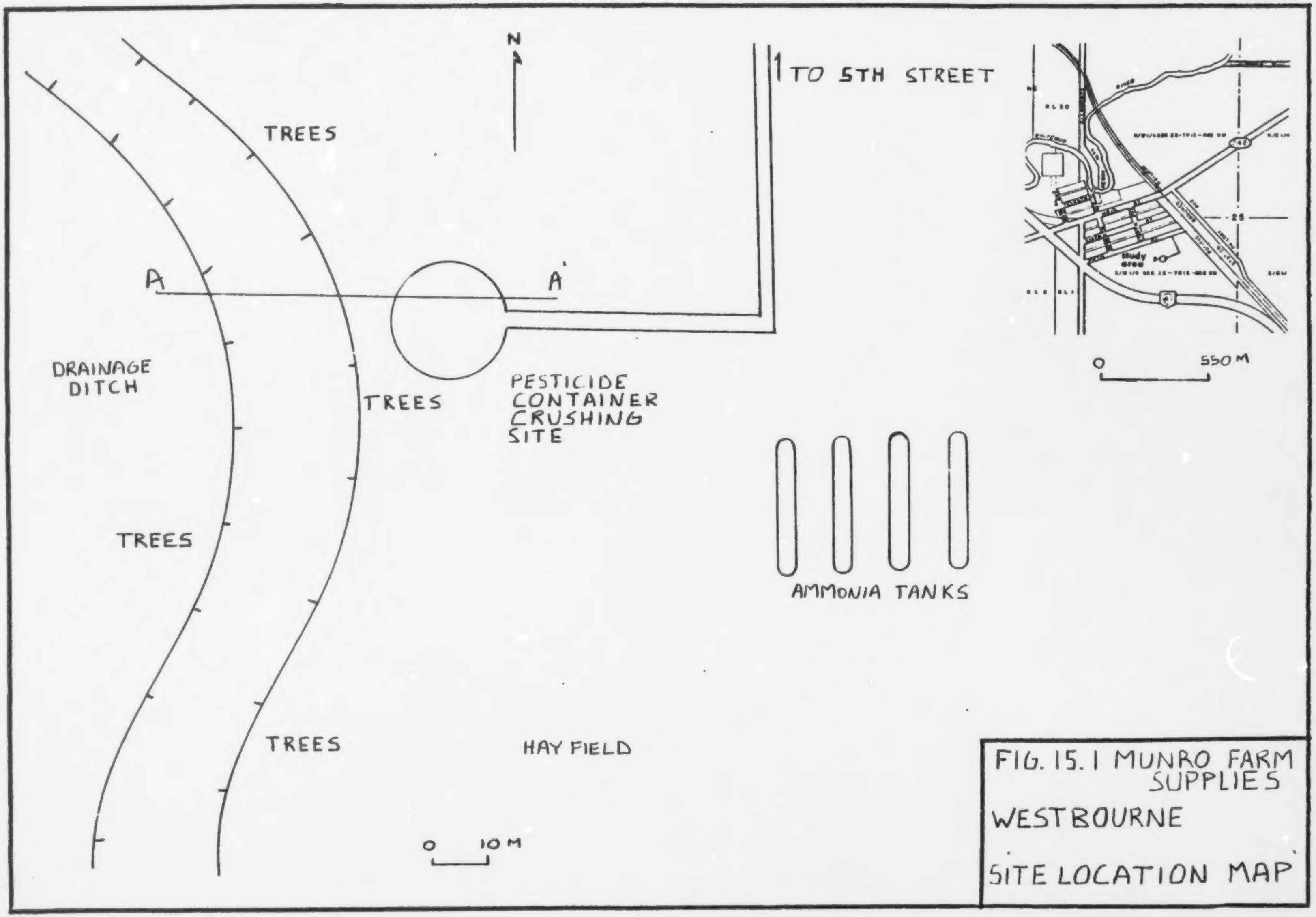

N
TO 5TH STREET
TREES
A
A'
DRAINAGE DITCH
TREES
PESTICIDE CONTAINER CRUSHING SITE
TREES
AMMONIA TANKS
TREES
HAY FIELD
0 10 M
Study area
0 550 M

FIG. 15.1 MUNRO FARM SUPPLIES

WESTBOURNE

SITE LOCATION MAP

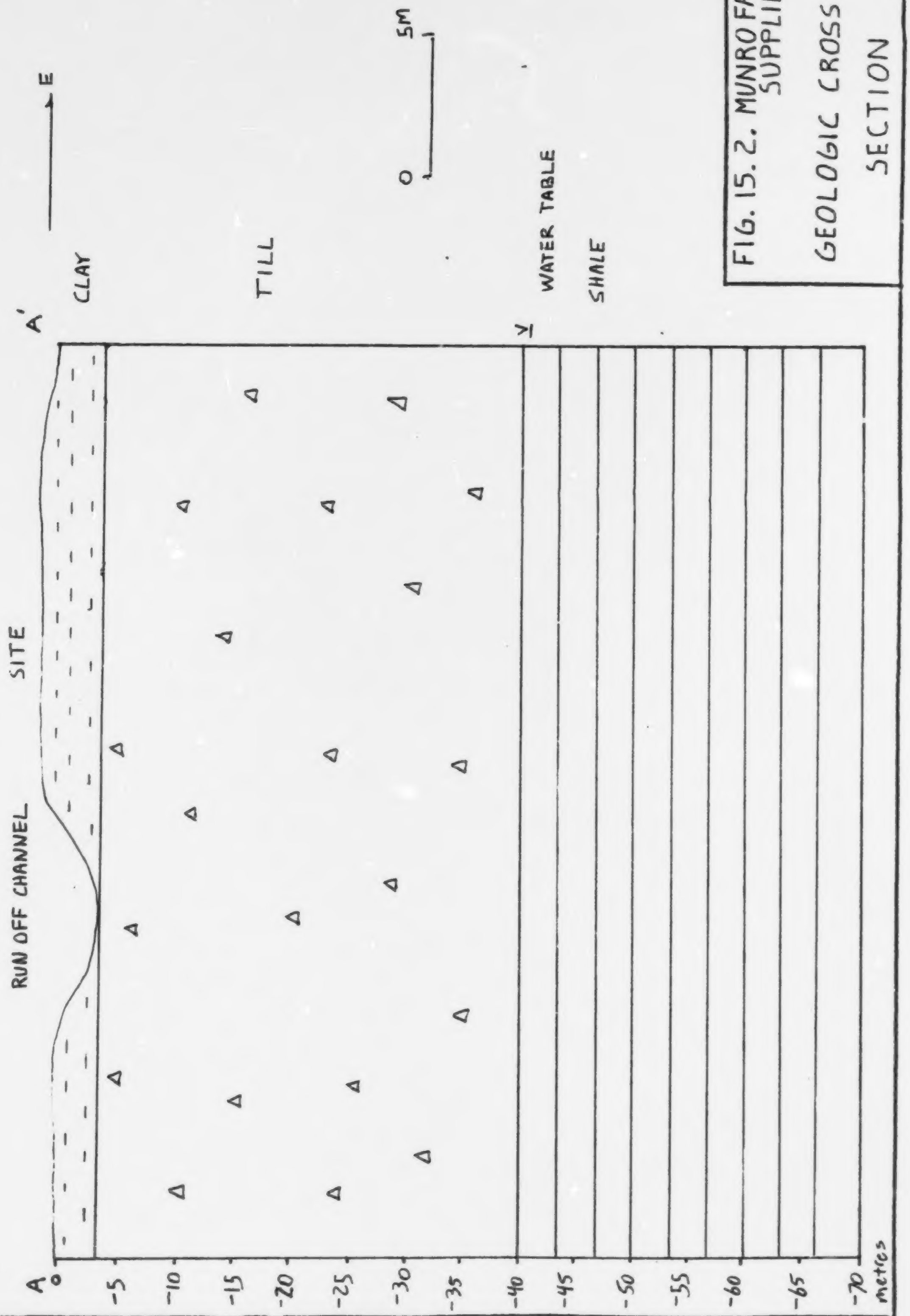

A
A'
RUN OFF CHANNEL
SITE
CLAY
TILL
WATER TABLE
SHALE
E
0
5M
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
-70
metres

FIG. 15. 2. MUNRO FARM SUPPLIES

GEOLOGIC CROSS SECTION

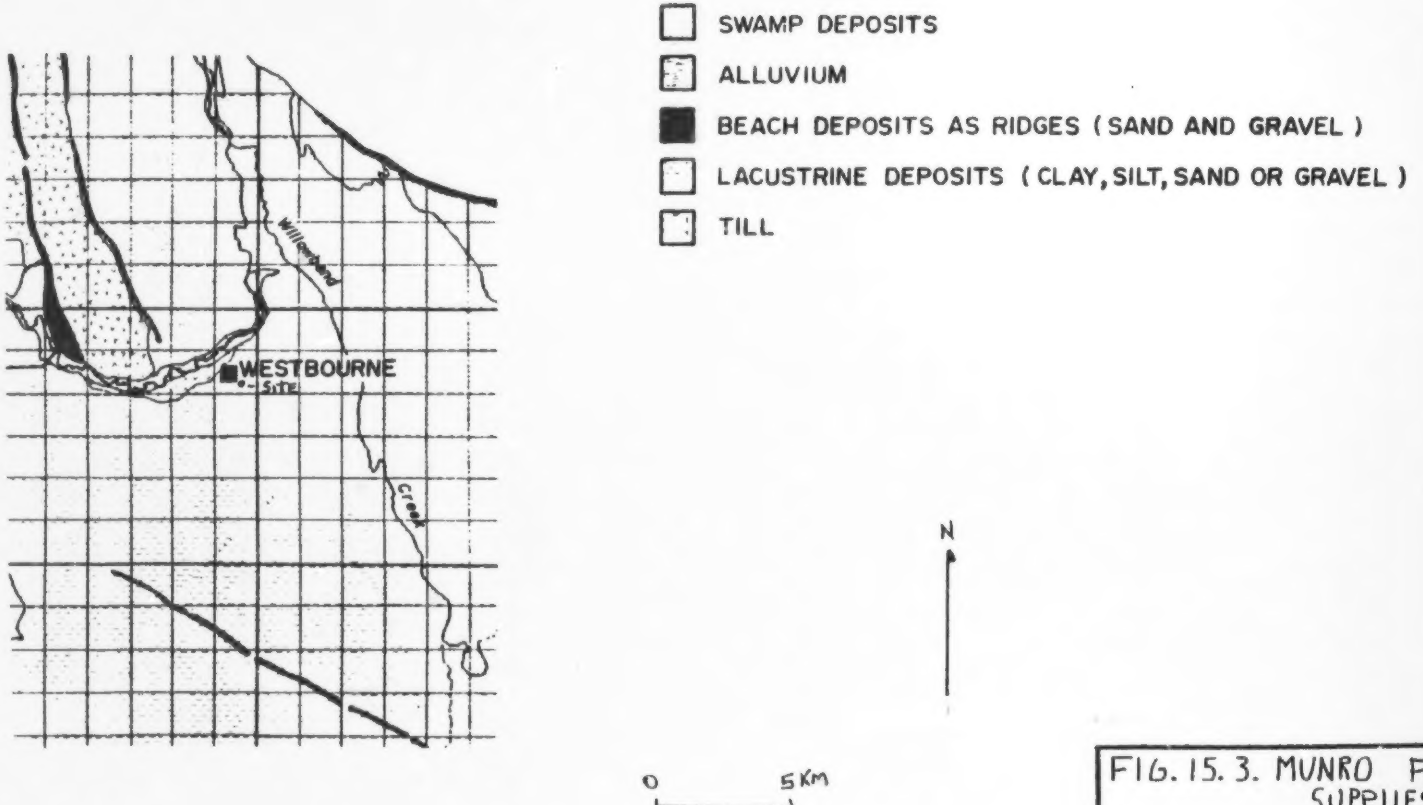

SWAMP DEPOSITS
ALLUVIUM
BEACH DEPOSITS AS RIDGES (SAND AND GRAVEL)
LACUSTRINE DEPOSITS (CLAY, SILT, SAND OR GRAVEL)
TILL
WESTBOURNE
SITE
Willowbend
Creek
N
0
5KM

FIG. 15. 3. MUNRO FARM SUPPLIES

SURFICIAL DEPOSITS MAP

CHAPTER - SIXTEEN -

PARKS BRANCH - LYNCH'S POINT CAMPGROUND

R.M. OF LAKEVIEW

SW 1-15-9W

16 PARKS BRANCH - LYNCH'S POINT CAMPGROUND

16.1 RECONNAISSANCE DATA

16.1.1 LOCATION

The campground of Lynch's Point, Manitoba, is located in the R.M. of Lakeview on the south shore of Lake Manitoba approximately 91 Km northwest of Winnipeg, at the end of P.R. 242. The site is located about 250 metres south of the campground on Section SW 1-15-9W (Figure 16.1).

16.1.2 PHYSIOGRAPHY

The area lies on the delta flats where the Whitemud River enters Lake Manitoba. The topography is very flat and open with a slight westerly dip towards the Whitemud River.

Vegetation is primarily grass and marshland with isolated clusters of oak and maple stands. The disposal site is bordered to the east and south by trees and to the north and west by flatland.

No drainage is evident around the site. The absence of stagnant water and drainage suggest rapid ground infiltration of precipitation.

16.1.3 BACKGROUND

This waste disposal site has been operating in its present location, in the campground for over 10 years. In 1977, the site was registered with the Province as an existing waste disposal ground.

Recent records indicate that this site serves a seasonal population of 250 people. Primarily campground wastes is deposited at this site. A trench method of dispoal is used.

The water supply for the campground is derived from shallow dug wells.

16.2.4 SITE CONDITIONS

During the site inspection on September 11, 1984, several observation were made. Access to the site is via a dirt road which runs 250 metres south from the campground across a hay field. The active area of the site is 5 x 8 metres with a trench 1.5 m x 4 m by 1.5 m. Disposal of waste is by trench dumping followed by burial with fill. The area is not fenced, but the overall condition of the site is in fair condition. There are no buildings in the vicinity of the site area.

16.1.5 DRILLING AND SAMPLING

Drilling and sampling was not conducted at this site.

16.2 GEOLOGIC DATA

16.2.1 GEOLOGIC SETTING

The site area is located on silty sands of the Lake Agassiz basin next to the shore of Lake Manitoba. The sands are underlain by glacial till. The silty sand appears to be continuous from the site to the shoreline. The underlying clay till is also assumed to be continuous and sloping towards the lake bed (see Figure 16.2).

16.2.2 BEDROCK

Fracture shale bedrock from the Jurassic Period underlies the site at a depth of about 30 metres below grade.

16.2.3 OVERBURDEN

Bedrock is overlain by about 25 metres of clay till and 5 metres of surficial sands. The till is of low permeability and contains only minor lenses of sand and gravel. In some parts of this area, the surficial sand is covered by a thin layer of clay, silt and swamp deposits (see Figure 16.3).

16.2.4 GEOHYDROLOGY

Two aquifers exist in this area. The sand unit forms a shallow unconfined aquifer which is hydraulically connected to Lake Manitoba. The wells on the camp site are set into this aquifer.

Fractured zones in the shale form a bedrock aquifer which is confined by the impermeable till layer. Water quality in the bedrock is poor and no wells are set into it around the site area.

16.3 ENVIRONMENTAL INTERPRETATION AND ASSESSMENT

16.3.1 LEACHATE HYDROLOGY

The sand unit on which the site is located forms the aquifer from which water is drawn for the campground. Consequently, the disposal site is pollution sensitive.

The present amount of waste is very small and located above the groundwater table. Accordingly, leachate generation is still small and is not likely to affect the campground water supply.

16.3.2 METHANE

Based on the amount of waste deposited at this site an estimated 0.5 million cubic metres of methane gas may be produced each year. Since the area is relatively dry the actual amount generated will only be a fraction of the maximum estimate. Migration of methane gas should be limited to a distance of 30 m based on the permeability of the surrounding soil.

16.3.3 WATER QUALITY

The soil in the vicinity of the disposal site has some attenuating capacity, based on the clay percentage. This capacity reduces the likelihood of noticeable contamination of ground water in the area at this time.

16.3.4 CONCLUSION

The sand unit beneath the site forms a local aquifer; and thus, the area is pollution sensitive. A well on the campground is set into this local aquifer about 400 m north of the site.

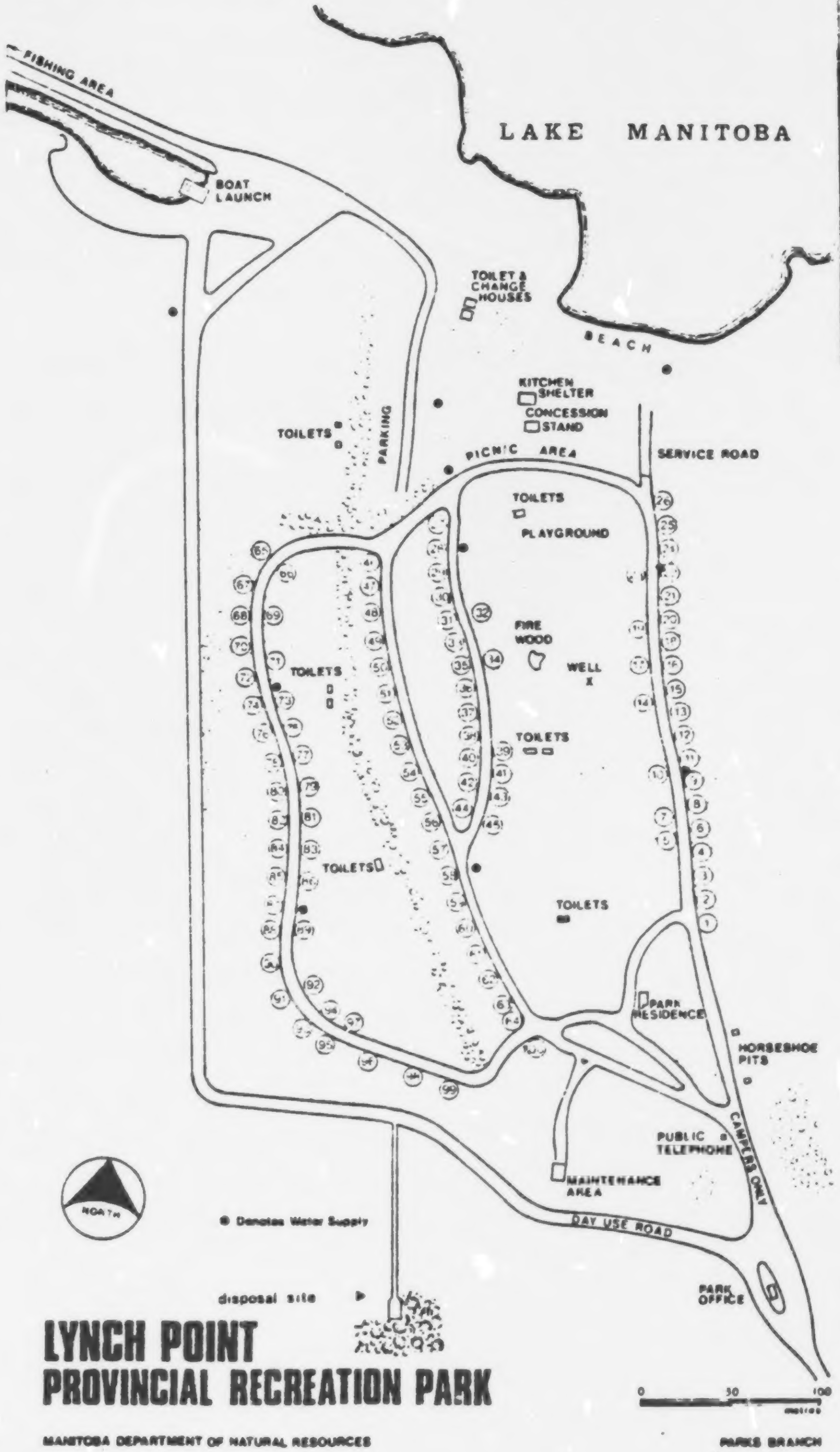
Since the amount of waste at this site is small and located above the water table, the effect on local groundwater quality is still low. Therefore, drinking water in the well is not likely affected at this point.

16.2.4 RECOMMENDATIONS

a) The water quality in the campground well should be monitored annually.

b) Should the amount of waste disposed annually increase, a new site should be considered.

FIG. 6.1 LYNCH POINT
SITE LOCATION MAP


FISHING AREA
BOAT LAUNCH
LAKE MANITOBA
TOILET & CHANGE HOUSES
BEACH
KITCHEN SHELTER
CONCESSION STAND
TOILETS
PARKING
PICNIC AREA
SERVICE ROAD
TOILETS
PLAYGROUND
FIRE WOOD
WELL
TOILETS
TOILETS
TOILETS
TOILETS
PARK RESIDENCE
HORSESHOE PITS
PUBLIC TELEPHONE
CAMPERS ONLY
MAINTENANCE AREA
DAY USE ROAD
PARK OFFICE
NORTH
● Denotes Water Supply
disposal site
LYNCH POINT
PROVINCIAL RECREATION PARK
0
30
100
metres
MANITOBA DEPARTMENT OF NATURAL RESOURCES
PARKS BRANCH

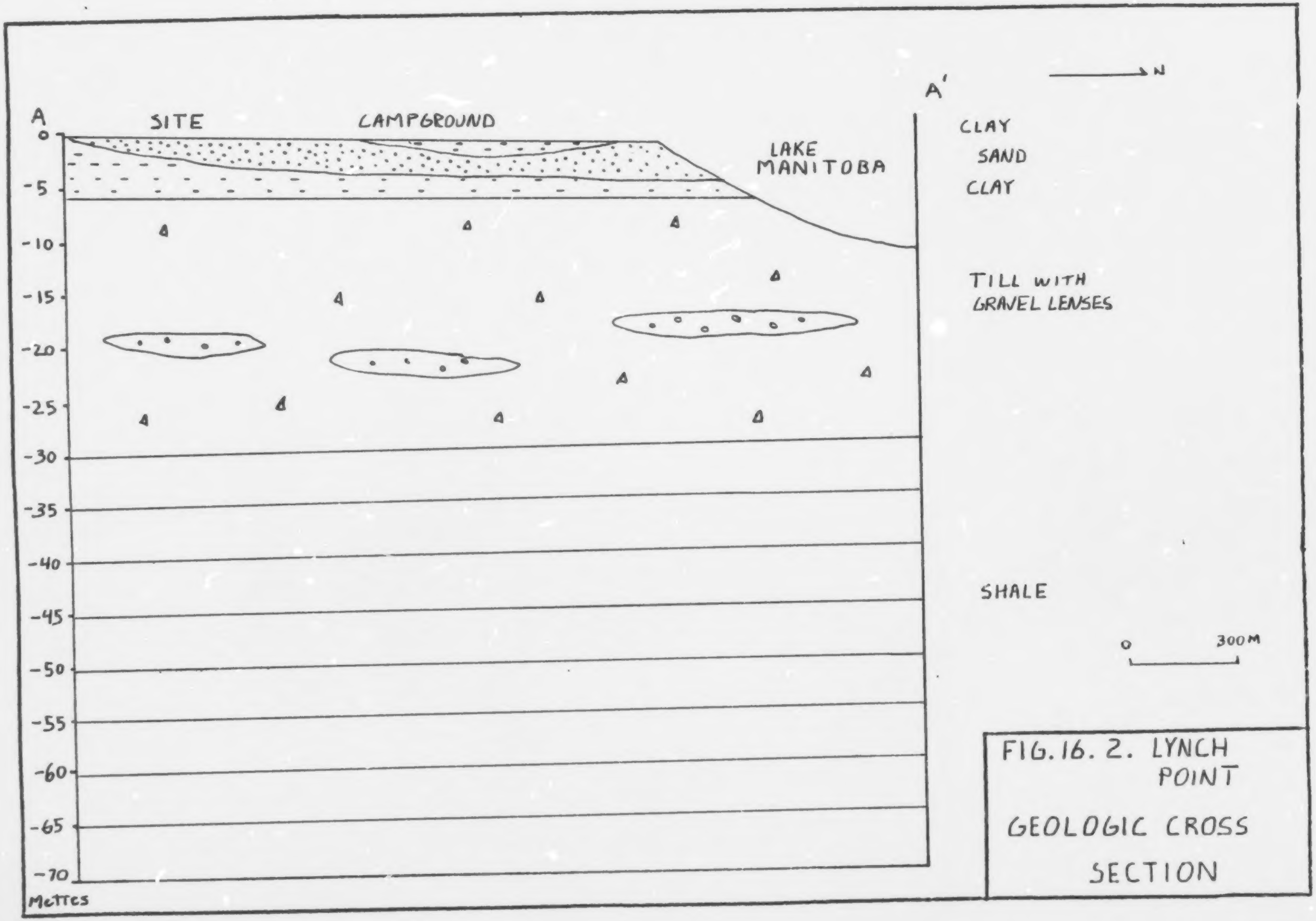

A
A'
N
SITE
CAMPGROUND
LAKE MANITOBA
CLAY
SAND
CLAY
TILL WITH GRAVEL LENSES
SHALE
0
300M
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
-70
Metres

FIG. 16. 2. LYNCH POINT

GEOLOGIC CROSS SECTION

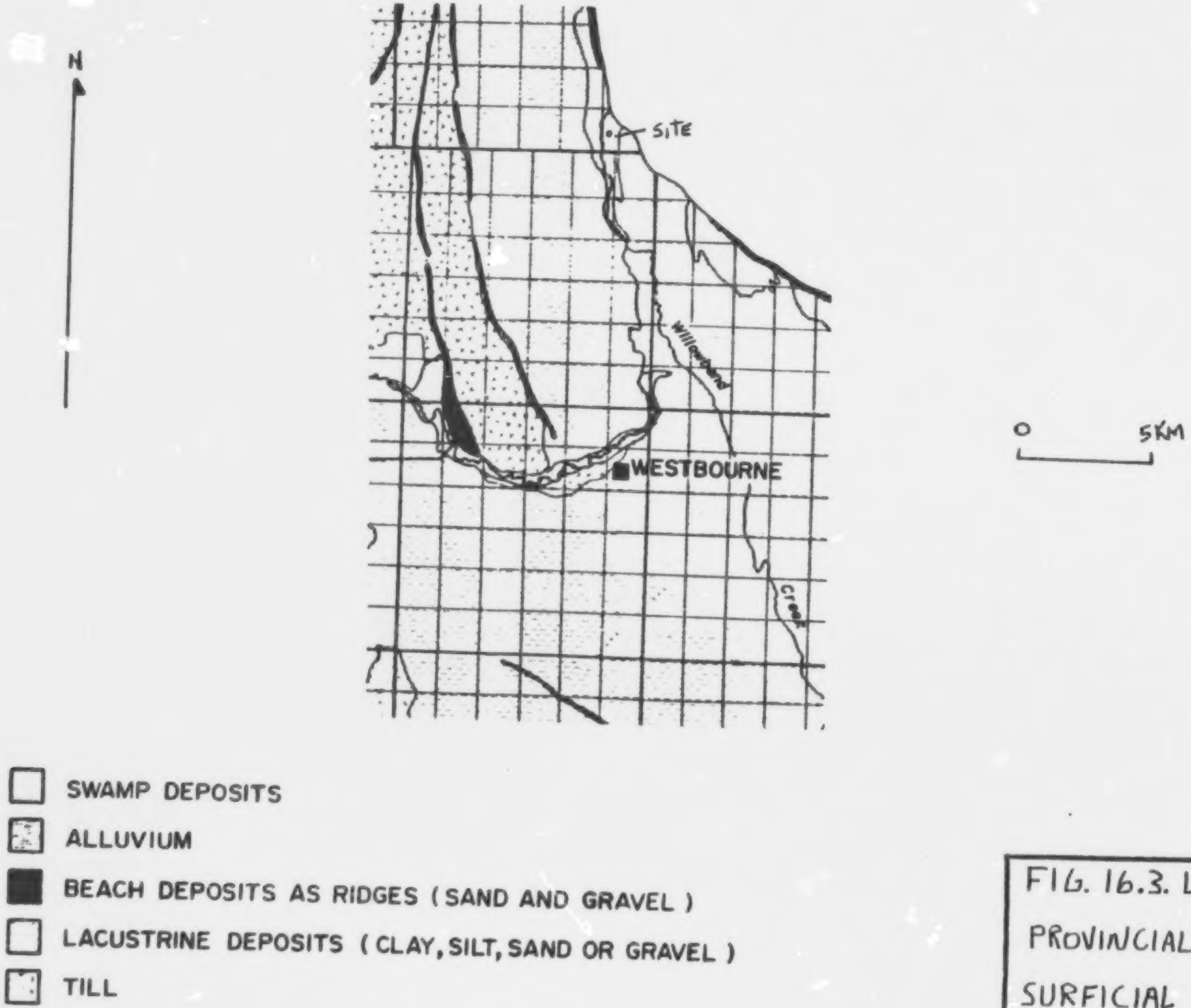

N
SITE
Willowbend
WESTBOURNE
Creek
0
5KM
☐ SWAMP DEPOSITS
▨ ALLUVIUM
■ BEACH DEPOSITS AS RIDGES (SAND AND GRAVEL)
☐ LACUSTRINE DEPOSITS (CLAY, SILT, SAND OR GRAVEL)
▨ TILL

FIG. 16.3. LYNCH POINT PROVINCIAL PARK SURFICIAL DEPOSITS MAP

CHAPTER - SEVENTEEN -

PARKS BRANCH - STEPHENFIELD PROVINCIAL PARK CAMPGROUND

SW 36-6-7W

17 PARKS BRANCH - STEPHENFIELD WASTE DISPOSAL SITE

17.1 RECONNAISSANCE DATA

17.1.1. LOCATION

Stephenfield Recreational Provincial Park is located in the R.M. of Dufferin, and is approximatly 70 Km southwest of Winnipeg, off P.T.H. 245. The waste disposal site is located in the southwest corner of the park, on Section SW-36-6-7W (Figure 16.1).

17.1.2 PHYSIOGRAPHY

The area lies in a region of sand flats with gently rolling hills. The immediate area of the site is generally flat with little vegetation. Several mature trees are found in the site area. Overall the area is dominated by agricultural fields, some with irrigation. The regional and local drainage is into the Boyne River, which is dammed in the park to create a lake.

17.1.3 BACKGROUND

The waste disposal site has been located on the sand flat since the park was opened over 15 years ago. The site serves a transient campground population of approximately 300 during the camping season.

The nearest well to the site is located 100 m to the east and is located in the maintenance building. A well located 400 metres northeast of the site serves the campground users.

17.1.4 SITE CONDITIONS

During the site inspection on September 25, 1984, several observations were made. Access to the site is from a dirt road which runs 150 m west from the rear of the maintenance building. The site is approximately 25 m by 3 m in size with an active area of 3 m by 2 m. The disposal method used is trench deposition followed by burning. Twice a year the waste is covered with fill and buried. The site is in fair condition. Overall the location of the site is good.

17.1.5 DRILLING AND SAMPLING

Drilling and water sampling were not undertaken at this site.

17.2 GEOLOGIC DATA

17.2.1 GEOLOGIC SETTING

The site is located in the southern part of the pro-glacial Assiniboine delta. A layer of yellow delta sand overlies silt and clay deposits from glacial Lake Agassiz which in turn overlie the calcareous till Bedrock at depth (see Figure 17.2).

17.2.2 BEDROCK

The bedrock in this area consists of dark petroliferous shale. The shale is part of the Ashville Formation from the Cretaceous Period and can be encountered at a depth of 60 metres below grade.

17.2.3 OVERBURDEN

Three separate sediment units form 60 metres of overburden covering bedrock. The deepest layer consists of roughly 15 metres of glacial till. The till is calcareous, dense and clayey with low permeability.

Roughly 45 metres of interbedded lacustrine clays and silty sands form the middle layer. This unit is clastic and permeable in the upper part but clayey and impermeable at depth.

The third and surficial unit consists of about 2 to 3 metres of clean sand. This sand is a late deltaic deposit which is highly permeable (Figure 17.3).

17.2.4 GEOHYDROLOGY

The surficial sand and the interbedded silty sands in the upper part of the lacustrine deposits form the major unconfined aquifer in this area. Shallow wells are set into these sands and used extensively as water supply for the campground.

The water table is reported at 3 to 5 metres below grade in this area, with groundwater recharge occurring by direct infiltration of precipitation. The general subsurface flow of groundwater is atop the clay layers in a north to east direction. These clay layers and the underlying till form an impermeable boundary which separates the aquifer from the geology at greater depth.

17.3 ENVIRONMENTAL INTERPRETATION AND ASSESSMENT

17.3.1 LEACHATE HYDROLOGY

The sand unit on which the site is located forms the aquifer from which water is drawn for the campground. Consequently, the disposal site is pollution sensitive.

The present amount of waste is very small and located above the groundwater table. Accordingly, leachate generation is still small and contamination from the site will not likely affect the campground water supply.

17.3.2 METHANE

Based on the amount of waste deposited at this site an estimated 0.5 million cubic metres per year of methane gas may be produced. However, since most of the waste is burned and the site is relatively dry, the actual quantity of methane gas generated will only be a fraction of the estimate. Migration of methane gas from the site should be limited to 20 metres based on the permeability of the soils.

17.3.3 WATER QUALITY

The water quality of the shallow sand and gravel aquifers of this region is considered very good. The soil in the area of the site has a limited capacity to attenuate contaminants, therefore, the groundwater is sensitive to surface pollution.

17.3.4 CONCLUSION

The disposal site is located directly on an unconfined sand aquifer. Two wells, located 100 and 400 metres downgradient of the site pump from this aquifer for the campground water supply. Consequently, the site and surrounding area are pollution sensitive.

To date, the environmental impact posed by this site is still very low. The amount of waste is small and seasonal. Leachate generation is limited because the disposed waste is usually in dry soil above the water table. Therefore, drinking water is not likely affected at this point.

17.3.5 RECOMMENDATIONS

a) The water quality in both wells should be monitored annually.

b) Should the amount of waste disposed annually increase, a new site should be considered.

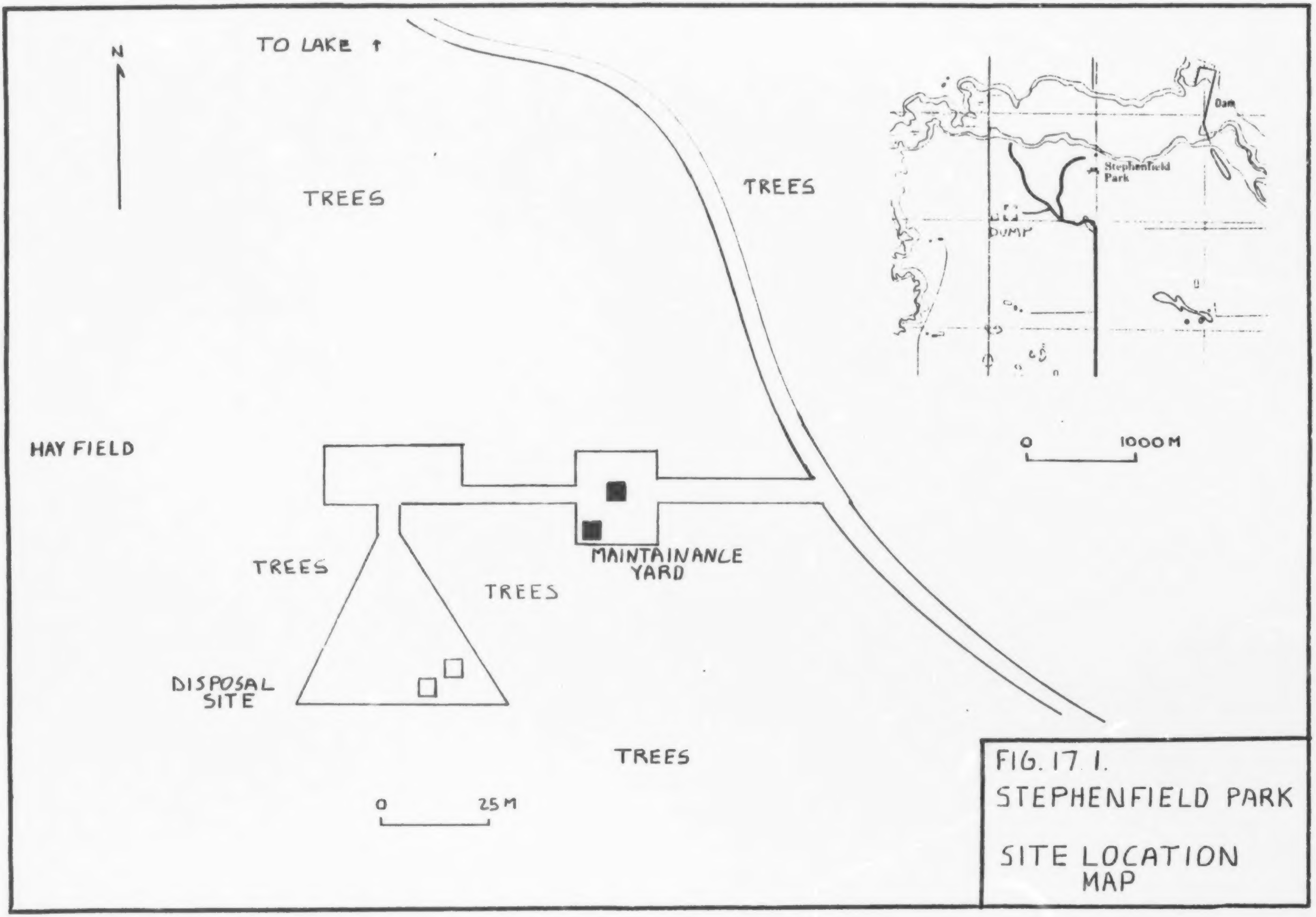

N
TO LAKE ↑
TREES
TREES
Dam
Stephenfield Park
DUMP
0
1000 M
HAY FIELD
MAINTAINANCE YARD
TREES
TREES
TREES
DISPOSAL SITE
0
25 M

FIG. 17.1.
STEPHENFIELD PARK

SITE LOCATION MAP

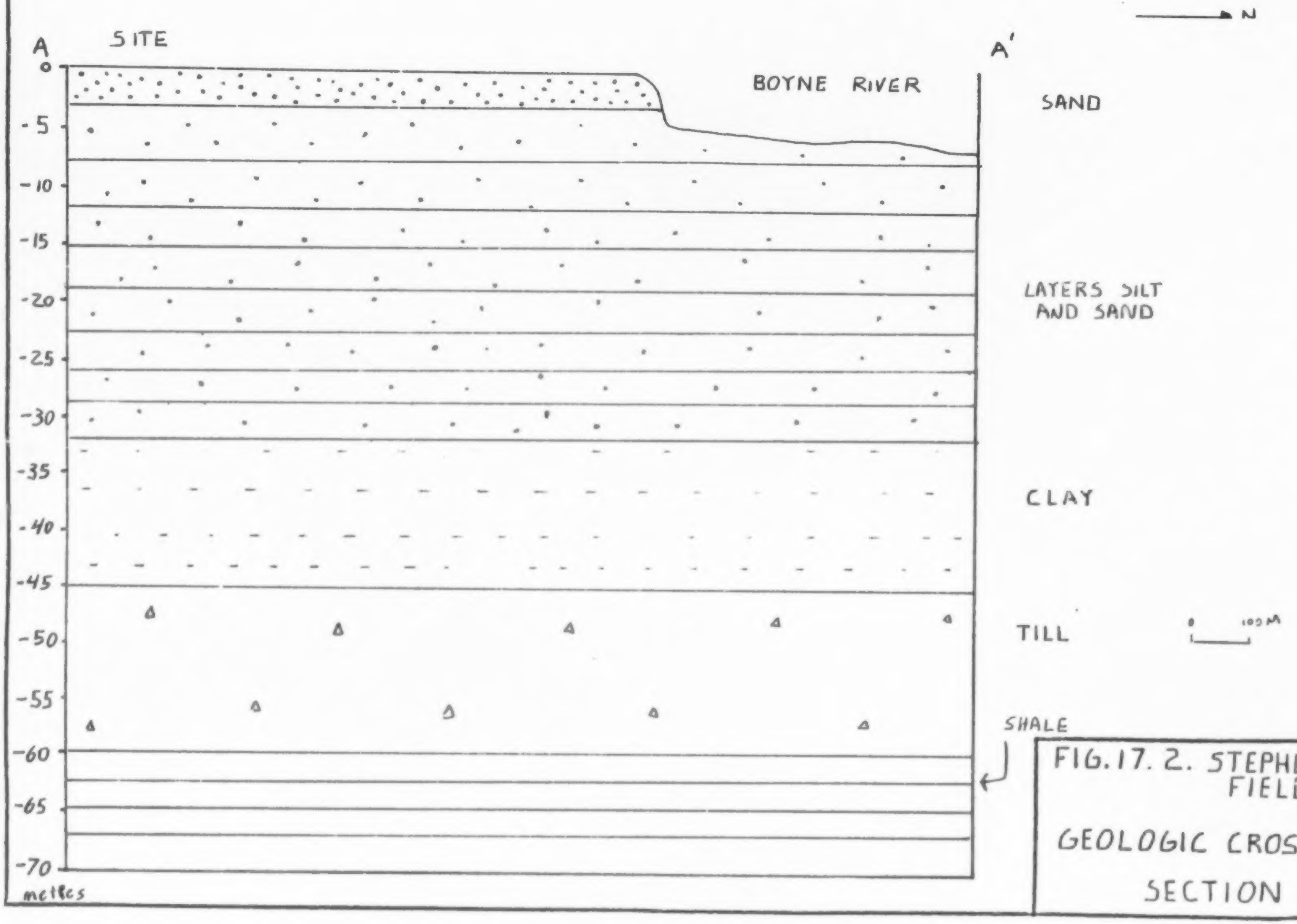

N
A
A'
SITE
BOYNE RIVER
SAND
LAYERS SILT AND SAND
CLAY
TILL
SHALE
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
-70
metres
0
100M

FIG. 17. 2. STEPHEN FIELD

GEOLOGIC CROSS SECTION

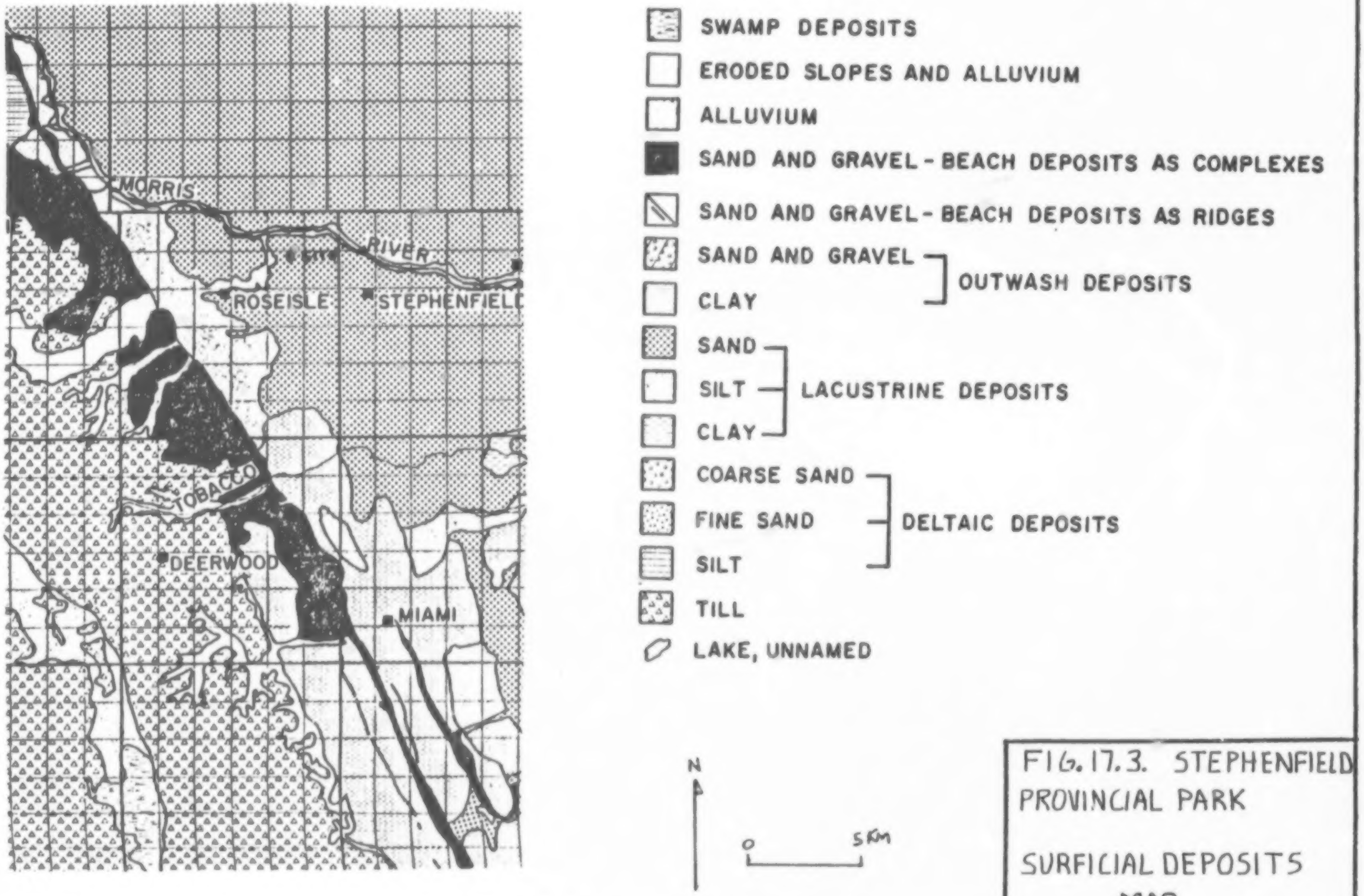

MORRIS
RIVER
ROSEISLE
STEPHENFIELD
TOBACCO
DEERWOOD
MIAMI
SWAMP DEPOSITS
ERODED SLOPES AND ALLUVIUM
ALLUVIUM
SAND AND GRAVEL - BEACH DEPOSITS AS COMPLEXES
SAND AND GRAVEL - BEACH DEPOSITS AS RIDGES
SAND AND GRAVEL
CLAY
OUTWASH DEPOSITS
SAND
SILT
CLAY
LACUSTRINE DEPOSITS
COARSE SAND
FINE SAND
SILT
DELTAIC DEPOSITS
TILL
LAKE, UNNAMED
N
0
5KM

FIG. 17.3. STEPHENFIELD PROVINCIAL PARK

SURFICIAL DEPOSITS MAP

CHAPTER - EIGHTEEN -

SIDNEY

R.M. NORTH NORFOLK

NW 19-11-12W

18 SIDNEY WASTE DISPOSAL SITE

18.1 RECONNAISSANCE DATA

18.1.1 LOCATION

The Town of Sidney, Manitoba, is located within the R.M. of North Norfolk approximately 121 km west of Winnipeg along the Trans-Canada Highway. The waste disposal site is located about 800 metres west of the town and 850 metres north of the highway on Section NW 9-11-12W (see Figure 18.1).

18.1.2 PHYSIOGRAPHY

The area is located on the rolling sand flats of the ancient Assiniboine Delta which connects the Southwestern Uplands with the Manitoba Lowlands. The area features moderate relief with remnants of dunes, blowouts and sand flats. The site is located in a depressed area between dunes.

Local drainage around the site occurs in general by infiltration into the sandy soil. During snowmelt and periods of strong rain, surface runoff from the site towards the northeast is possible.

18.1.3 BACKGROUND

This waste disposal site has been operating on its current location for over 8 years. In 1977, the site was registered with the Province as an existing waste disposal site. Current records show that this site serves approximately 600 people. Primarily municipal waste from the Town of Sidney and household waste from surrounding rural areas, is deposited at this site. Above grade deposition is the current waste disposal method.

Water supply for the town and surrounding rural areas consists of privately owned wells. Septic waste disposal is also by individually owned septic tanks.

18.1.4 SITE CONDITIONS

During the site inspection of September 11, 1984, several observations were made. Access to the site is from a dirt road onto a half hectare clearing. Half of the site is situated on a natural depression which is successively filled by a 60 metre long and 2 metre high disposal terrace.

The waste disposal method used is burning, followed by above grade deposition with the occasional fill covering. There is a separate area for agricultural chemical containers. The site is fenced on 2 sides and the nearest dwelling is approximately 350 m south of the site.

It was noted that sewage and liquid fertilizer had been disposed at this site.

18.1.5 DRILLING AND SAMPLING

One monitoring well was installed at the site on November 19, 1984. The well is located on Figure 18.1 and the soil log is summarized in Table 18.2.

On January 3, 1985, water samples were taken from the well and the nearby residence south of the site. The samples were submitted for analysis (see Table 18.1), and the results are discussed in Section 18.3.3.

18.2 GEOLOGIC DATA

18.2.1 GEOLOGIC SETTING

The area is located on the far eastern part of the proglacial Assiniboine Delta. Surficial windblown sands overly a thick interbedded delta deposit of silt, sand and clay. This delta deposit forms a major unconfined aquifer in this part of Manitoba (see Figure 18.2).

18.2.2 BEDROCK

Bedrock in this area consists of dark shales from the Cretaceous Period. Depth to bedrock is estimated at 135 m below grade.

18.2.3 OVERBURDEN

Two major sediment units form roughly 135 m of overburden in this area. Approximately 45 m of dense clay till forms the lower unit while 90 m of deltaic sediments form the overlying unit.

The deltaic unit consists of interbedded silts, sands and clay. In general, the lower part of this unit is clayey and of low permeability while sands predominate in the upper part. The surficial 20 m are composed of clean, sorted sand (See Figure 18.3).

18.2.4 GEOHYDROLOGY

The deltaic sediment unit beneath the site is part of a major unconfined aquifer in this region. Recharge occurs by direct infiltration of precipitation into the surficial sands.

The water level in the monitoring well was taken at 14 metres below grade. The geology suggests that the groundwater flows in an easterly to northeasterly direction.

The nearest well set into the aquifer is located 350 m south of the site.

18.3 ENVIRONMENTAL ASSESSMENT AND INTERPRETATION

18.3.1 LEACHATE HYDROLOGY

Since the surficial sand unit forms an unconfined aquifer, this area is pollution sensitive. Precipitation infiltrating through the buried waste may carry contaminants to the groundwater at depth.

The amount of waste deposited at this site is still small, and located in dry sand well above the water table. Accordingly, the production of leachate is small and occurs only during periods of aquifer recharge. Groundwater beyond the boundaries of Section NW 9-11-12W is not likely to be affected.

Since no wells are located on this property, drinking water is not likely to be contaminated by this site.

18.3.2 METHANE

Based on the amount of waste deposited at this site an estimated 3 million cubic metres of methane gas per year may be generated.

Since waste is burned before burial, the actual quantity of methane gas generated should be only a fraction of this estimate.

Since waste is deposited above grade, methane gas migration should be limited to approximately 5 metres. Methane gas likely vents directly into the atmosphere with little subsurface migration.

18.3.3 WATER QUALITY

Chemical analysis of water samples taken from the monitoring well located on the waste disposal site and of a nearby residence appears to show no signs of leachate contamination (see Table 18.1).

The monitoring well sample shows a lead and chromium concentration higher than objective limits, but this appears to be natural in occurrence, as is the high total organic carbon level.

The residence well sampled can be considered to have good quality water.

18.3.4 CONCLUSION

The disposal site is located in a pollution sensitive area. During periods of aquifer recharge by rain and snowmelt, local groundwater contamination is possible. Drinking water of residential wells in the area is not likely to be affected by this process, and water samples taken from the monitoring well and a nearby residence showed no signs of contamination by this site.

This site is not considered suitable for the disposal of sewage and liquid fertilizer. Liquid waste may permeate through the clean sand quickly and cause sporadic leachate slugs to contaminate groundwater.

18.3.5 RECOMMENDATIONS

a) Liquid fertilizer and sewage should not be deposited at this site.

b) Resampling of the monitoring well and the nearby residence is recommended. Samples should be taken in spring when aquifer recharge is occurring.

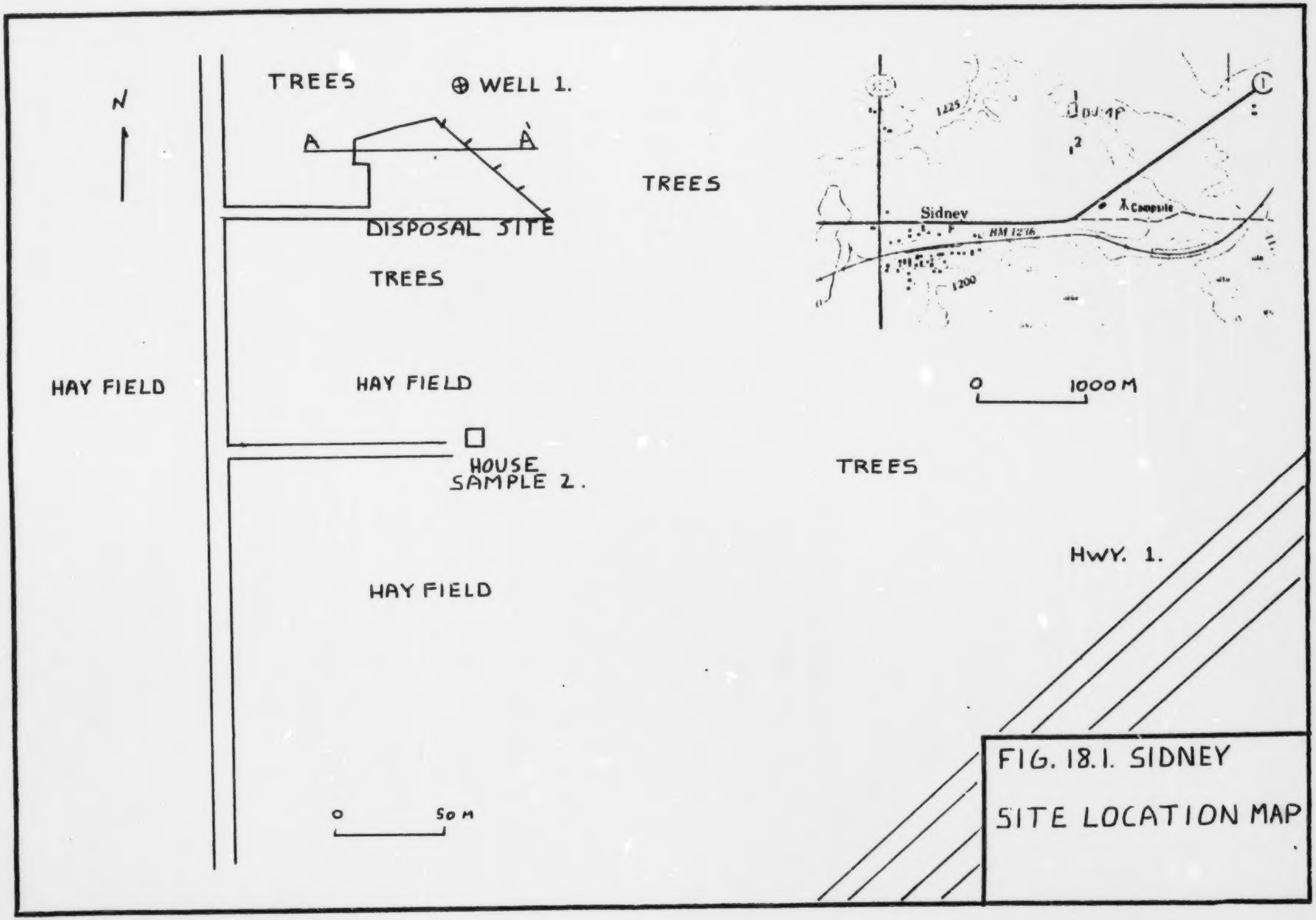

N
TREES
⊕ WELL 1.
A
Á
DISPOSAL SITE
TREES
TREES
HAY FIELD
HAY FIELD
HOUSE
SAMPLE 2.
HAY FIELD
0
50 M
Sidney
1225
1200
HM 1276
Campsite
DUMP
2
1
0
1000 M
TREES
HWY. 1.

FIG. 18.1. SIDNEY SITE LOCATION MAP

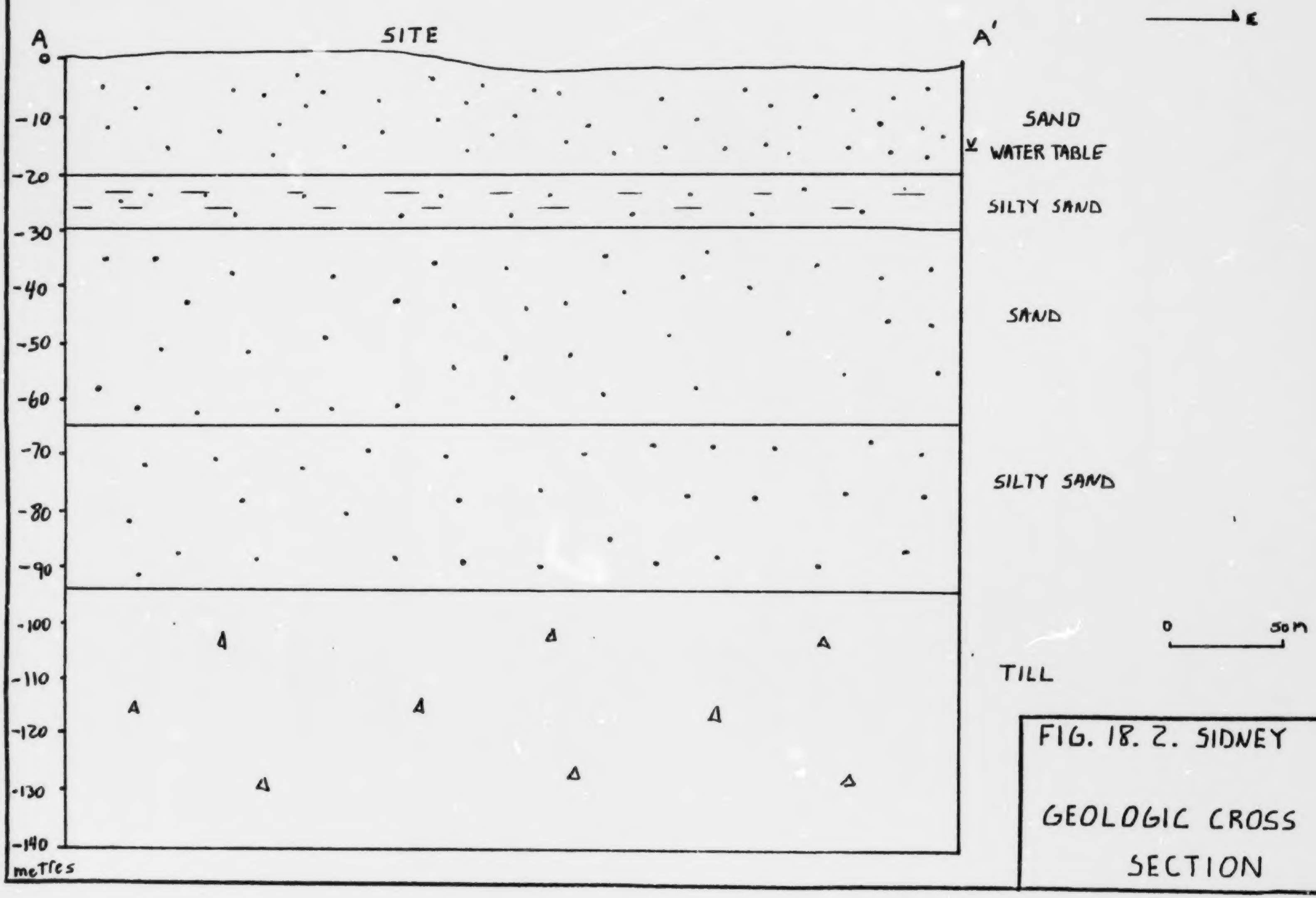

A
SITE
A'
E
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
metres
SAND
WATER TABLE
SILTY SAND
SAND
SILTY SAND
TILL
0
50m

FIG. 18. 2. SIDNEY

GEOLOGIC CROSS
SECTION

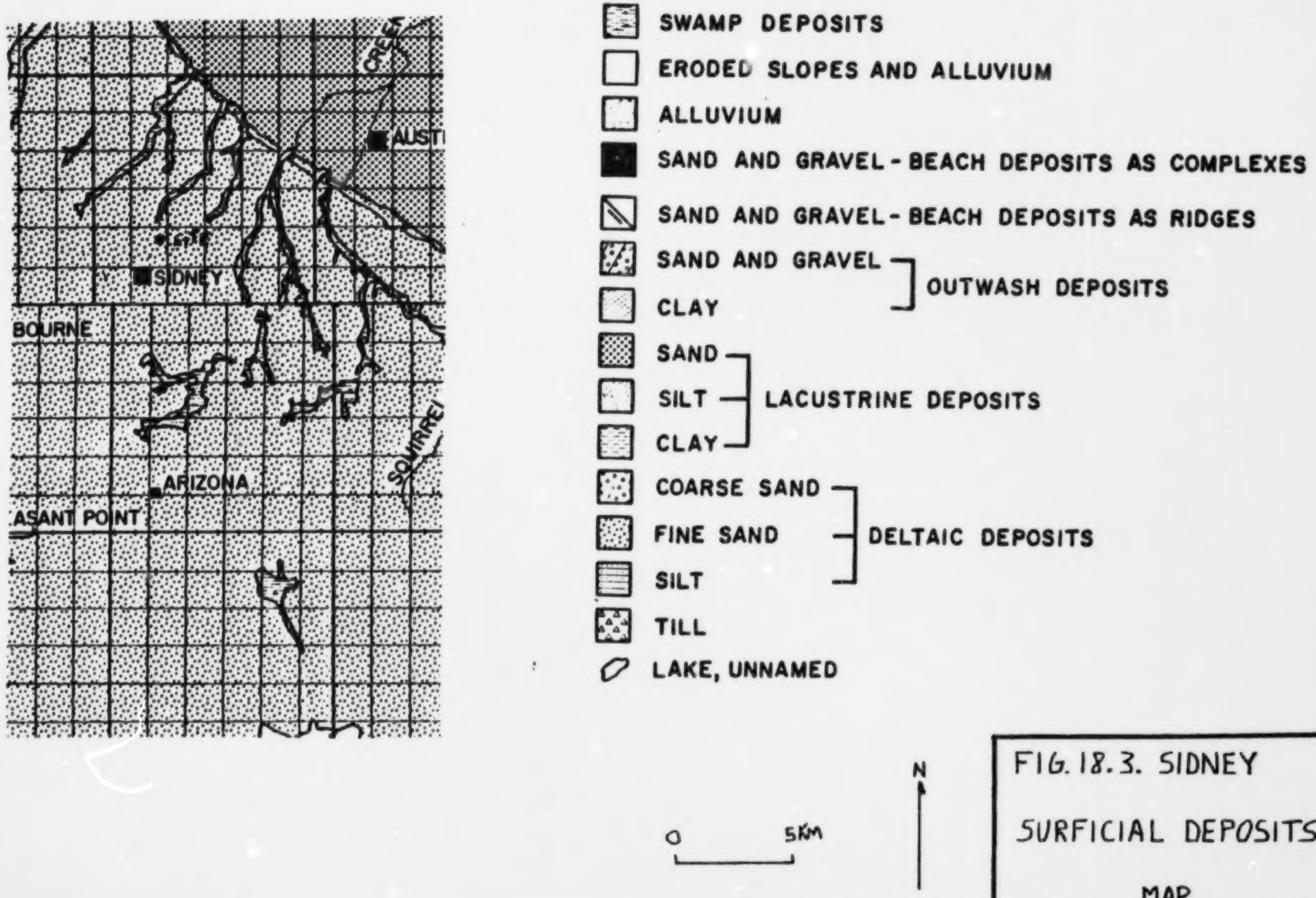

CREEK
AUSTI
SIDNEY
BOURNE
SQUIRREL
ARIZONA
ASANT POINT
SWAMP DEPOSITS
ERODED SLOPES AND ALLUVIUM
ALLUVIUM
SAND AND GRAVEL - BEACH DEPOSITS AS COMPLEXES
SAND AND GRAVEL - BEACH DEPOSITS AS RIDGES
SAND AND GRAVEL
CLAY
OUTWASH DEPOSITS
SAND
SILT
CLAY
LACUSTRINE DEPOSITS
COARSE SAND
FINE SAND
SILT
DELTAIC DEPOSITS
TILL
LAKE, UNNAMED
0
5KM
N

FIG. 18.3. SIDNEY SURFICIAL DEPOSITS MAP

TABLE 18.1. SIDNEY

Site Number	1	2		
Parameters				
Conductivity umho/cm	641	641		
Residue Total mg/L	420	400		
Residue Filt mg/L	390	400		
Residue Non-Filt mg/L	33	<5		
pH units	7.55	7.55		
Alkal. Total ($CaCO_3$) mg/L	318	320		
Alkalinity (HCO_3) mg/L	388	390		
Alkalinity (CO_3) mg/L	0	0		
Alkalinity (OH) mg/L	0	0		
As (Ext.) mg/L	.004	.009		
Cd (Ext.) mg/L	<.001	<.001		
Cu (Ext.) mg/L	.01	.02		
Pb (Ext.) mg/L	.022	<.005		
Ni (Ext.) mg/L	<.005	<.005		
Zn (Ext.) mg/L	.03	.07		
Cr (Total) mg/L	.015	<.005		
Calcium (Ext.) mg/L	84.5	<.5		
Magnesium (Ext.) mg/L	39.0	<.5		
Hardness ($CaCO_3$) mg/L	372	1.65		
Manganese (Ext.) mg/L	.65	<.02		
Iron (Ext.) mg/L	.72	.11		
Potassium (Ext.) mg/L	<5.00	<5.00		
Sodium (Ext.) mg/L	5.06	164		
COD mg/L	170	<2		
T.O.C. mg/L	84.	1.0		
Turbidity NTU	2.5	2.5		
CN (Free) mg/L	<.02	<.02		
Kjeldnal, Total-N mg/L	10.4	<.2		
NH_3-N (Sol.) mg/L	.03	.02		
NO_3-NO_2-N (Diss.) mg/L	.02	<.01		
P-Total mg/L	.07	.03		
Chloride (Sol.) mg/L	6	25		
Sulphate (Sol.) mg/L	47.5	6.90		
Fecal Coliform /100 mL	-	-		
Total Coliform /100 mL	-	-		

TABLE 18.2 SIDNEY SOIL LOGS

WELL #	DEPTH (METRES)	DESCRIPTION
1	0 - 3.3	fine to med. yellow sand
	3.3 - 4	soil horizon, dark brown silt
	4 - 24	sand, S.A.A.
	24 - 30	grey sand

CHAPTER - NINETEEN -

SOMERSET

R.M. OF LORNE

NE 20-5-9W

19 SOMERSET WASTE DISPOSAL SITE

19.1 RECONNAISSANCE DATA

19.1.1 LOCATION

The Town of Somerset, Manitoba, is located in the R.M. of Lorne, approximately 100 km southwest of Winnipeg. The waste disposal site is located approximately 1 km east of the town on Section NE 20-5-9W (see Figure 19.1).

19.1.2 PHYSIOGRAPHY

The area consists of gently rolling glacial till plains. The vegetation consists primarily of open prairie used as agricultural fields with some tree growth in channels and around dwellings.

Surficial waters occur in the form of seasonal ponds and runoff flow in creek channels. Regional drainage in the area is towards the north, while drainage around the site is to the southwest in a small drainage ditch.

19.1.3 BACKGROUND

This waste disposal site has been operating on its present site for more than 20 years. Historically refuse has been surficially disposed as evident by a large 4 m high mound covering half of the site. This mound is overgrown with vegetation.

In 1977, the site was registered with the Province as an existing waste disposal ground. Present records indicate this site serves a population of 700 people. Primarily municipal waste from the

Town of Somerset and household waste from the surrounding rural areas are deposited in a trench at this site. Bulky metallic wastes are kept in a separate pile.

Water supply for the area consists of privately owned small diameter wells set into the confined bedrock aquifers. Somerset is served by a two cell sewage lagoon which discharges into a small creek 350 m west of the disposal site.

19.1.4 SITE CONDITIONS

During the site inspection of September 25, 1984, several observations were made. Access to the site is directly off a Section Road. The site covers an area of 70 m by 70 m with an active disposal area of a trench. At the time of the inspection the trench was found to be full and overflowing, with fresh waste strewn over a large area. Some waste in the trench was burned. A large number of bulky metallic waste lined one side of the site. There are no fences, but the site is bermed. Overall the site is in poor condition due to its age and abundance of strewn waste.

19.1.5 DRILLING AND SAMPLING

A sampling and drilling program was not undertaken at this site.

19.2 GEOLOGIC DATA

19.2.1 GEOLOGIC SETTING

The area is located on the till plains of the Southwestern Uplands. In this region, a thin blanket of calcareous till covers the underlying bedrock (see Figure 19.2).

19.2.2 BEDROCK

The Odanah Member of the Riding Mountain Formation, a hard, dark grey shale forms the bedrock at a depth of 5 metres beneath the site. This shale contains extensive fracture zones which are saturated at depth.

19.2.3 OVERBURDEN

A single unit of overburden overlies bedrock. The unit consists of 5 metres of clayey calcareous till (see Figure 19.3).

19.2.4 GEOHYDROLOGY

Wells in this area draw water from fractured bedrock zones at 25 to 40 metres depth. The shale forms the only aquifer in this area. Due to the overlying till, this aquifer is at least partially confined, thus recharge occurs mainly from upstream aquifers and not by infiltration of precipitation.

19.3 ENVIRONMENTAL INTERPRETATION AND ASSESSMENT

19.3.1 LEACHATE HYDROLOGY

The clayey till beneath the site forms a low permeability boundary separating leachates from the bedrock aquifer. Leachates are generated on the site by precipitation infiltrating through the buried waste. Only small amounts of these contaminants are expected to permeate the entire thickness of the till. As a result, groundwater should not be affected by the site.

19.3.2 METHANE

Based on the amount of waste deposited at this site an estimated 4 million cubic metres of methane gas per year may be produced. However, since most of the waste was burned before burial and the site is relatively dry, the actual quantity of methane gas generated will only be a fraction of the estimate. Methane gas migration should be limited since most of the waste is deposited above grade. A migration distance of 30 m is suspected based on the permeability of the soil. However, it is likely that the majority of the methane gas generated will vent directly into the atmosphere with little subsurface migration.

19.3.3 WATER QUALITY

No wells are located in the vicinity of the site, therefore drinking water is not affected by this disposal site. Further, the clayey till beneath the site has a high capacity to attenuate cation contaminants and restrict infiltration. Overall, groundwater is not likely affected in the underlying aquifer.

19.3.4. CONCLUSION

Overall, this disposal site poses a low environmental impact to the area. Groundwater and drinking water should not be affected by this site. Methane generation and migration is not considered a problem since no buildings are located around the site area.

To date, the majority of the site is utilized. The trench method currently used unnecessarily decreases the thickness of the protective till subsurface. Also, waste is strewn throughout the site and not confined to the active area, affecting site appearance.

19.3.5 RECOMMENDATIONS

a) A return to the above surface pile and fill method is recommended.

b) Waste should be deposited in active areas only.

c) A new site should be located as this site is nearly full.

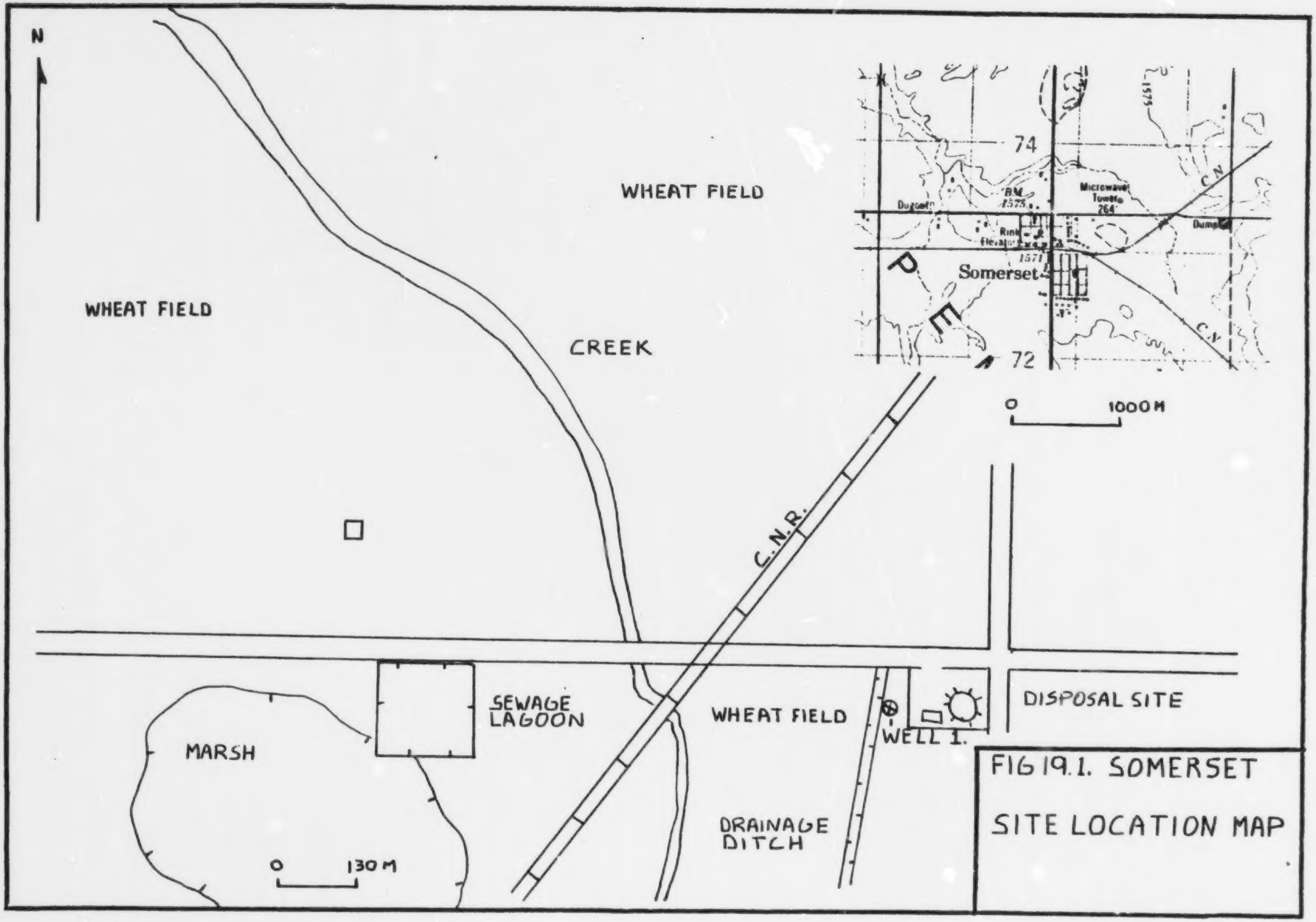

N
WHEAT FIELD
WHEAT FIELD
CREEK
C.N.R.
SEWAGE LAGOON
MARSH
0
130 M
WHEAT FIELD
WELL 1.
DRAINAGE DITCH
DISPOSAL SITE
0
1000 M
74
72
1575
Microwave Tower 264
Dump
R.M. 1575
Rink
Elevators
1571
Somerset
P E
C.N.
C.N.

FIG 19.1. SOMERSET SITE LOCATION MAP

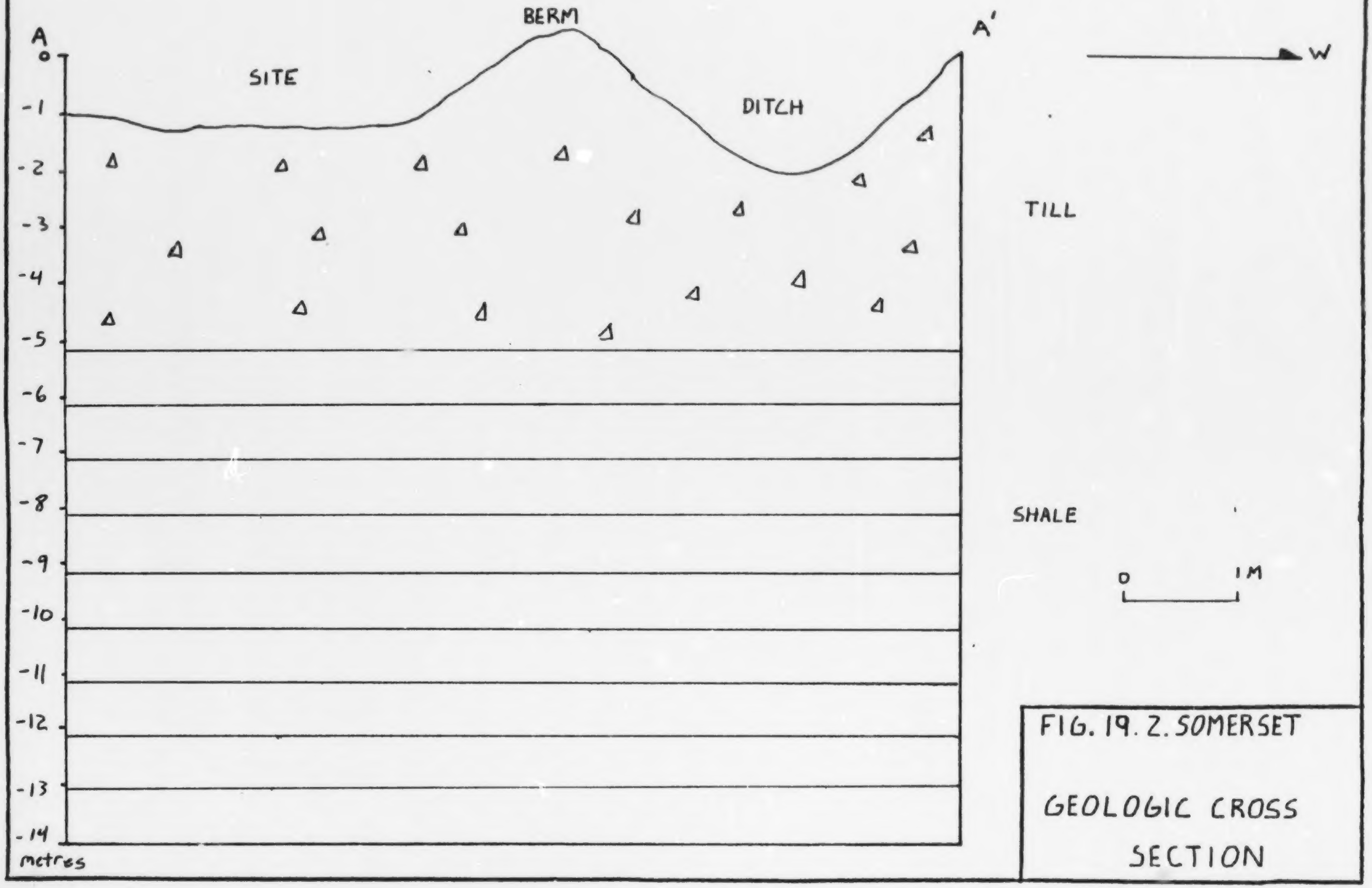

A
A'
W
SITE
BERM
DITCH
TILL
SHALE
0
1M
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
-10
-11
-12
-13
-14
metres

FIG. 19. 2. SOMERSET

GEOLOGIC CROSS SECTION

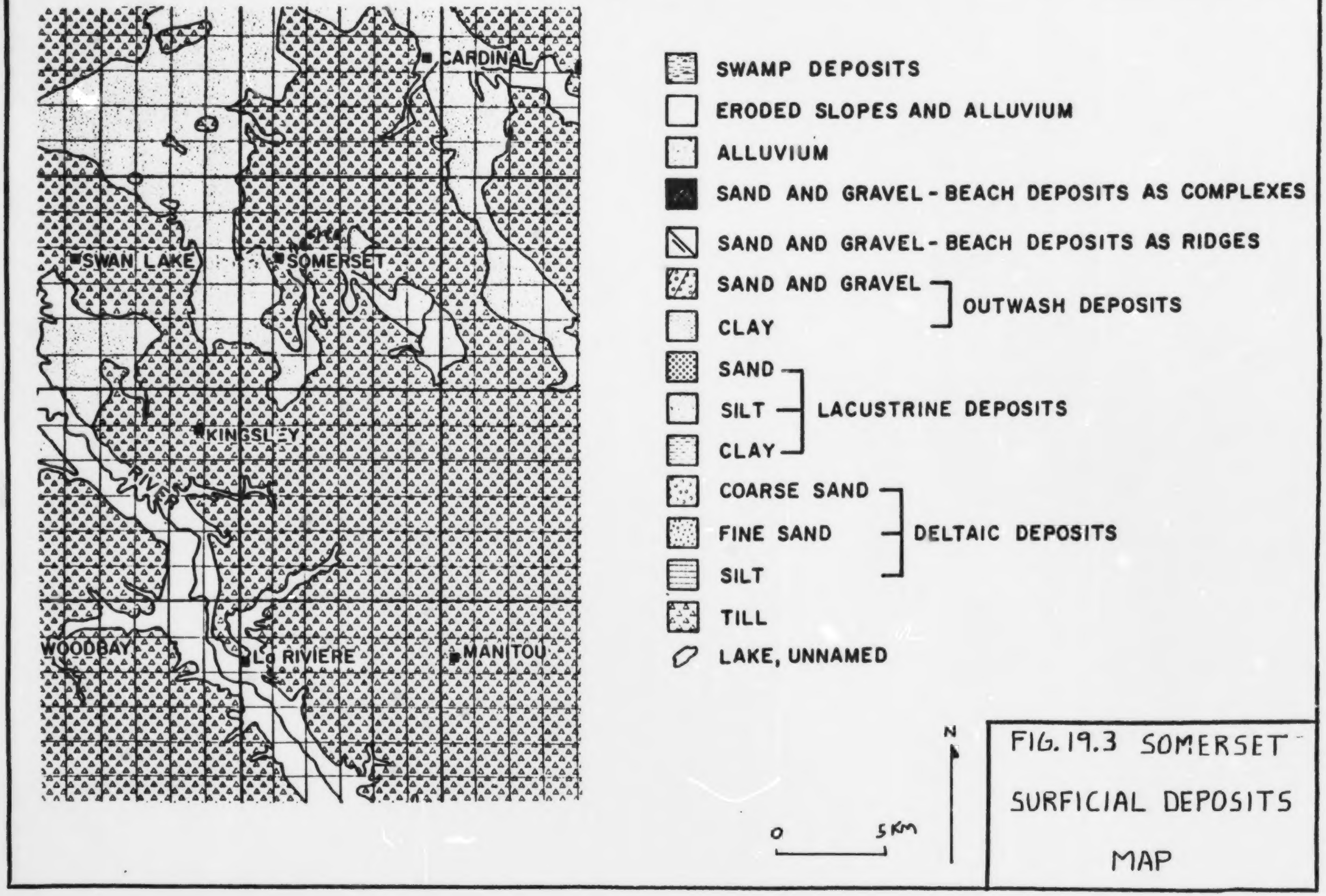

CARDINAL
SWAN LAKE
SOMERSET
KINGSLEY
RIVER
WOODBAY
La RIVIERE
MANITOU
SWAMP DEPOSITS
ERODED SLOPES AND ALLUVIUM
ALLUVIUM
SAND AND GRAVEL - BEACH DEPOSITS AS COMPLEXES
SAND AND GRAVEL - BEACH DEPOSITS AS RIDGES
SAND AND GRAVEL
CLAY
OUTWASH DEPOSITS
SAND
SILT
CLAY
LACUSTRINE DEPOSITS
COARSE SAND
FINE SAND
SILT
DELTAIC DEPOSITS
TILL
LAKE, UNNAMED
0
5KM
N

FIG. 19.3 SOMERSET SURFICIAL DEPOSITS MAP

CHAPTER - TWENTY -

SOURIS

R.M. OF GLENWOOD

NE 34-7-21W

20 SOURIS WASTE DISPOSAL SITE

20.1 RECONNAISSANCE DATA

20.1.1 LOCATION

The Town of Souris, Manitoba, is located within the R.M. of Glenwood, 200 km west-southwest of Winnipeg, off P.T.H. 2. The waste disposal site is located 500 metres east of the town along P.T.H. 2, on Section NE 34-7-21W (Figure 21.1).

20.1.2 PHYSIOGRAPHY

The site and town area borders two physiographic regions. The lake basin deposits consists of prairie flatlands with little relief. This area lies north-northeast of town. Running through this region is the Souris River glacial spillway. Currently, the Souris River meanders through its valley.

The site is located on the border of the valley on the outside curve of a meander bend. The site is approximately 15 metres above the Souris River water level. Slumping on this side of the bank has occurred.

On the opposite site of the river, a large gravel pit is in operation. The vegetation in the area consists basically of agricultural crops; however, along the river, mature trees and grasses are found. Regional and site drainage is into the Souris River.

20.1.3 BACKGROUND

The waste disposal site has been operating in this location for over ten years. In 1977, the site was registered with the

Province as an existing waste disposal site. Recent records indicate that the site serves approximately 1500 people. Primarily municipal waste from the Town of Souris and household waste from surrounding rural areas are deposited at the site. A trench system is used to dispose of common household waste, while bulky metallic wastes are collected on the surface.

Public water supply is derived from an upstream pumping station while, private water supply is derived from small diameter wells set into bedrock aquifer. The area is also served by a communal septic tank which empties downstream from the site.

20.1.4 SITE CONDITIONS

During the site inspection on September 18, 1984, several observations were made. Access to the site is off P.T.H. 2. The site situated along the south side of the highway, 500 metres east of town. The site is approximately 175 m by 175 m with an active trench, 150 m by 5 m by 3 m deep. The waste disposal method is trench deposition, burning, followed by burial when the trench is full. Smoke from fires in the trench at times obscures visibility on P.T.H. 2. Bulky metallic waste and tires are deposited on the surface in separate piles. However, some bulky metallic wastes have been deposited on the Souris River embankment.

Overall the site is well kept and in good condition. The location of the site is adequate except for smoke drift and waste on the riverbank.

20.1.5 DRILLING AND SAMPLING

Two small hand auger wells were installed at the edge of the Souris River. The locations are as indicated on Figure 20.1. Hole #1 was dug to 1.1 metre into the alluvial deposits; Hole #2 is 1.5 metres. The soil logs are summarized in Table 20.1.

The wells were frozen during a routine sampling visit is December, 1984 and no samples were taken.

20.2 GEOLOGIC DATA

20.2.1 GEOLOGIC SETTING

The disposal site is located at the edge of a 15 metre bluff leading down to the Souris River Valley. The meandering activity of the river has historically undercut this embankment and oversteepened the natural slope. Consequently, sections of the bluff have slumped into the valley with time.

The surficial sediment unit consists of a mixture of interbedded silt and sand. At depth, clay, gravel and bedrock rubble may be found overlying fractured shale bedrock (see Figure 20.2).

20.2.2 BEDROCK

Hard shale bedrock may be encountered at a depth of about 10 metres beneath the site. This shale is commonly referred to as the Odanah Member of the Riding Mountain formation which forms a drinking water aquifer in various parts of southwestern Manitoba.

20.2.3 OVERBURDEN

Approximately 10 metres of overburden cover the bedrock. A layer of shale rubble separates bedrock from the overlying sediments. Interbedded silt and clay grades upward into gravel and fine sand near the surface (see Figure 20.3).

20.2.4 GEOHYDROLOGY

The freshwater aquifer in this area consists of saturated fracture zones in the bedrock. The river is an exposed part of the water table in this aquifer.

Groundwater flows from beneath the site towards the Souris River. The permeable overburden allows recharge of the bedrock aquifer by infiltration of precipitation.

20.3 ENVIRONMENTAL INTERPRETATION AND ASSESSMENT

20.3.1 LEACHATE HYDROLOGY

Leachates are generated on this site by infiltration of precipitation into the buried waste. Downward migration carries contaminants to the groundwater table and with local hydraulic gradients towards and with the river flow direction.

The amount of leachate generated should be limited because the buried waste is located in dry sediments above the water table. Contamination of drinking water is also not likely since no wells exist between the disposal site and the Souris River.

20.3.2 METHANE

Based on the amount of waste deposited at this site an estimated 7 million cubic metres of methane gas may be produced per year. However, since most of the waste is burned before burial, and the site is relatively dry, the actual quantity of methane gas produced is suspected to be only a fraction of the estimate. Methane gas migration should be limited to 40 metres at this site, given the good permeability of the soil.

20.3.2 WATER QUALITY

Localized contamination of the fractured shale bedrock aquifer could occur between the site and the river. However no wells exist in this area so groundwater quality is not considered a problem at this site.

20.3.4 CONCLUSION

This site poses a moderately low environmental impact. Since the site is located close to the Souris River, groundwater should be contaminated only in the small area between the site and the river. No wells are located in this area and thus, drinking water in the area is not affected. Methane gas generation should not be a problem since no buildings are located around the site area.

Southerly winds may cause smoke drift across P.T.H. 2 and be a hindrance to traffic.

20.3.5 RECOMMENDATIONS

a) No waste should be deposited within at least 30 metres of the bluff to avoid disturbing deposited waste by slumping. Waste presently deposited in this area should be moved.

b) A tree lined greenbelt between the site and the highway is desirable to avoid smoke drift.

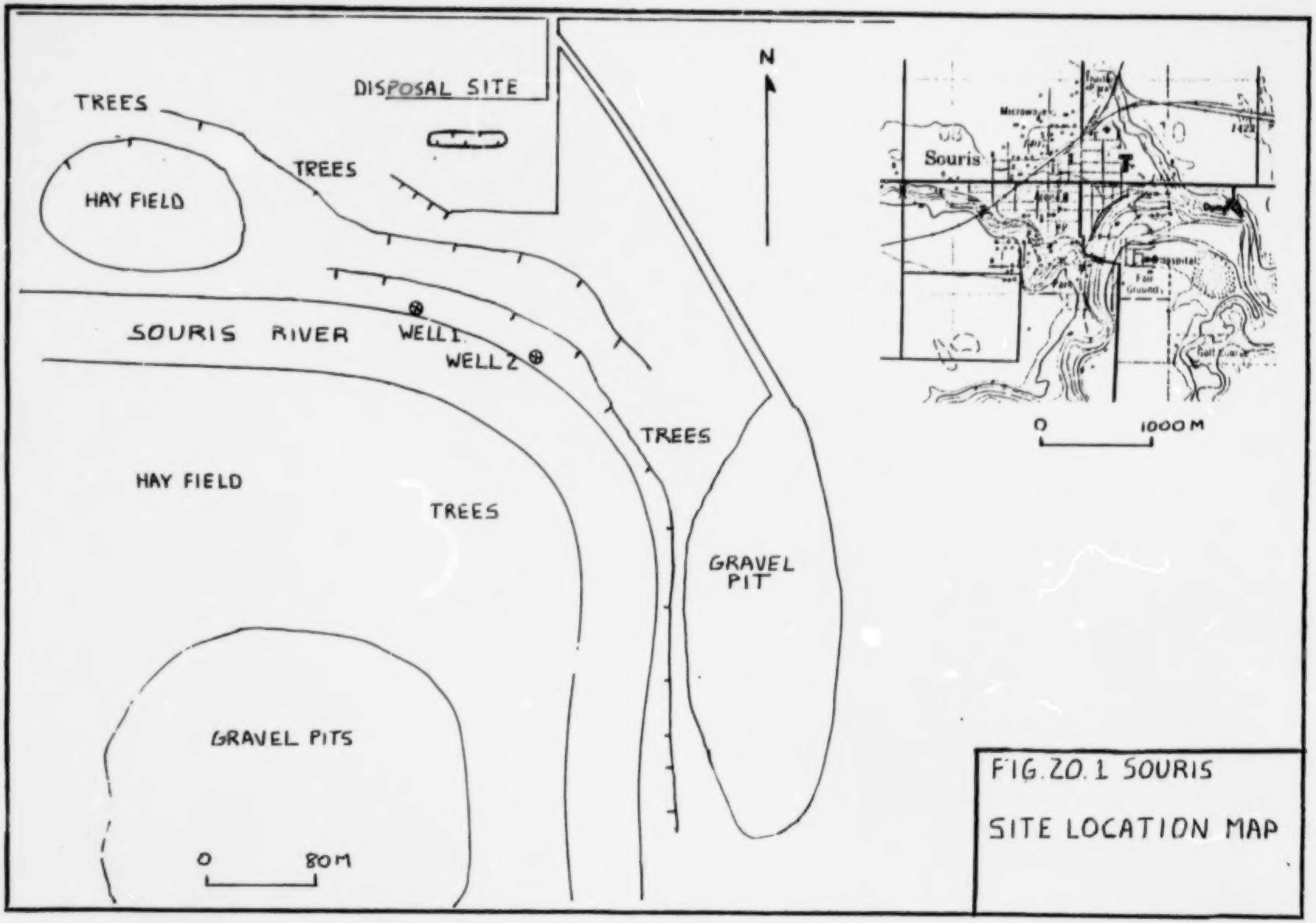

TREES
DISPOSAL SITE
N
HAY FIELD
TREES
SOURIS RIVER
WELL 1
WELL 2
TREES
HAY FIELD
TREES
GRAVEL PIT
GRAVEL PITS
0
80M
Souris
Microwave
Hospital
Fair Grounds
Golf Course
1423
0
1000M

FIG. 20.1 SOURIS SITE LOCATION MAP

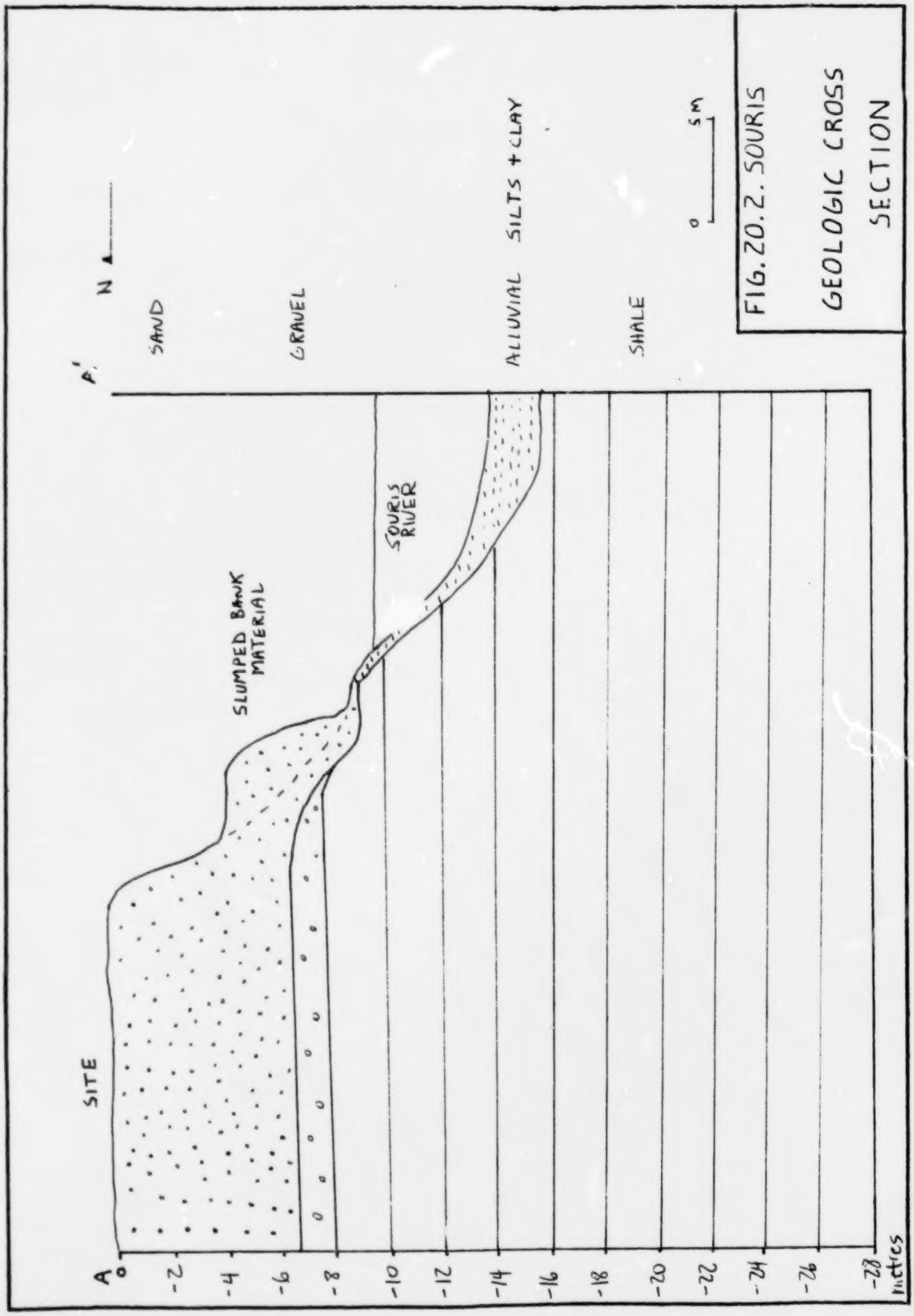

A
A'
SITE
SLUMPED BANK MATERIAL
SOURIS RIVER
N
SAND
GRAVEL
ALLUVIAL SILTS + CLAY
SHALE
0
5M
0
-2
-4
-6
-8
-10
-12
-14
-16
-18
-20
-22
-24
-26
-28
metres

FIG. 20.2. SOURIS GEOLOGIC CROSS SECTION

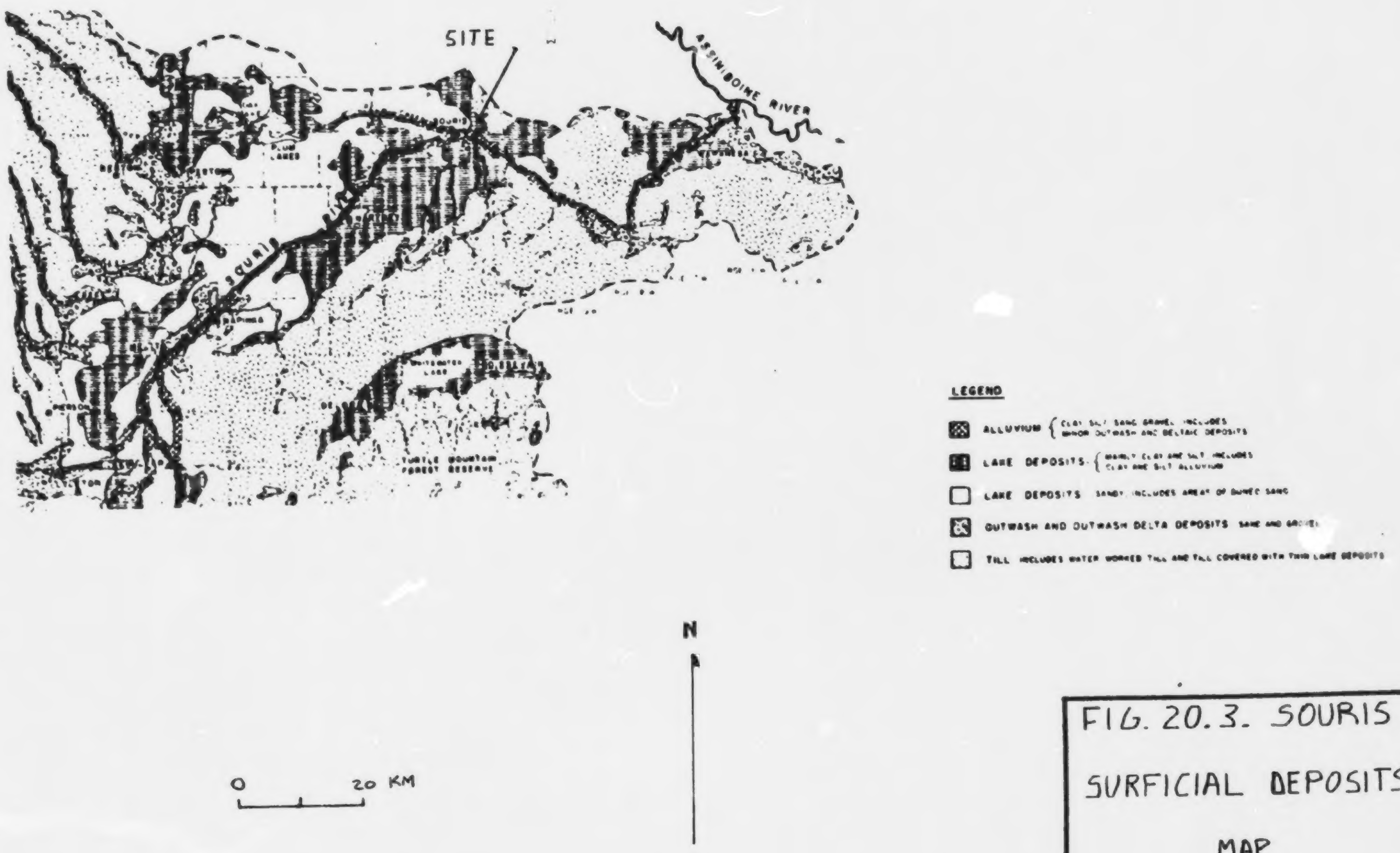

SITE
ASSINIBOINE RIVER
SOURIS
SOURIS RIVER
TURTLE MOUNTAIN FOREST RESERVE
LEGEND
▩ ALLUVIUM { CLAY SILT SAND GRAVEL INCLUDES MINOR OUTWASH AND DELTAIC DEPOSITS
■ LAKE DEPOSITS { MAINLY CLAY AND SILT INCLUDES CLAY AND SILT ALLUVIUM
☐ LAKE DEPOSITS SANDY INCLUDES AREAS OF DUNES SAND
▩ OUTWASH AND OUTWASH DELTA DEPOSITS SAND AND GRAVEL
☐ TILL INCLUDES WATER WORKED TILL AND TILL COVERED WITH THIN LAKE DEPOSITS
N
0
20 KM

FIG. 20.3. SOURIS
SURFICIAL DEPOSITS
MAP

TABLE 20.1 SOURIS SOIL LOGS

WELL #	DEPTH (METRES)	DESCRIPTION
1	0 - .5	river silt and clay
	.5 - 1.3	gravel geaded
2	0 - 1	river silt and clay
	1 - 1.3	gravel, graded

CHAPTER - TWENTY ONE -

THE PAS INDIAN RESERVE

LATITUDE 53° 21' 50" N

LONGITUDE 101° 19' 35" W

21 THE PAS INDIAN RESERVE WASTE DISPOSAL SITE

21.1 RECONNAISSANCE DATA

21.1.1 LOCATION

The Pas Indian Reserve is located within the Consol Government District of Manitoba, approximately 488 km northwest of Winnipeg along P.T.H. 10 and P.R. 289. The waste disposal site is located on Reserve 21E at latitude 53° 52' 50" N and longitude 101° 19' 35" W.

21.1.2 PHYSIOGRAPHY

The area is located in the Manitoba Lowlands where the Saskatchewan River basin bisects The Pas Moraine. The basin features extensive marshland surrounding the shallow Reader Lake. A steep, 25 m escarpment rises across ancient beach ridges onto the swampy uplands of The Pas Moraine.

The disposal site is situated on the toe of the escarpment about 3 m above the adjacent marshland. Three distinctive vegetation groups are represented in the area. A predominant population of birch and poplar woods grow on the basic till soils; interspersed areas of conifer growth cover the granular soil on the beach ridges; willows and wetlands distinguish the adjacent marshland.

21.1.3 BACKGROUND

The disposal site currently serves a population of about 1200 people from The Pas Indian Reserve. Predominently household waste with some agricultural and light industrial waste is deposited at this site. Sludge from the local treatment plant is regularly disposed of here, and disposal of oils from a nearby truck stop occurs intermittently.

The estimated site area is about 2 hectares at the edge of Reader Lake Marsh. The closest residence is located over 1.8 km south of the site.

21.1.4 SITE CONDITIONS

A number of observations were made during a site inspection on December 03, 1984. Access to the site is on a 450 m long dirt road down the slope of the escarpment.

A muddy truck loop allows access to a 60 m wide disposal area. Disposal consists of surface deposition with occasional burning; infrequently, machinery is used to cover the waste with sandy till from the site area. The covered waste forms a 3 m high mound which partially encroaches the marsh.

Fences, signs or allocated areas for separate waste do not exist.

21.1.5 DRILLING AND SAMPLING

A drilling program was not conducted at this site.

A water sample was taken from the adjacent marsh on December 03, 1084 and submitted for analysis. The results are included in Table 1.1 and discussed in Section 21.3.3.

21.2 GEOLOGIC DATA

21.2.1 GEOLOGIC SETTING

Predominantly, the subsurface consists of low permeability till. Locally, gravel deposits form ancient beach ridges along the slopes of the Moraine. Swamp and alluvial deposits overly the till in the adjacent marshland (see Figure 21.2).

21.2.2 BEDROCK

Limestone bedrock from the Silurial Age underlies the site at an estimated depth of 25 m.

21.2.3 OVERBURDEN

Approximately 25 m of glacial till underlies the site.

21.2.4 GEOHYDROGEOLOGY

The glacial till is generally of low permeability and supports few local aquifers. No wells are reported in this area. The groundwater table is assumed to be 2 to 3 metres beneath the site with a hydraulic gradient in direction of the marsh.

21.3 ENVIRONMENTAL INTERPRETATION AND ASSESSMENT

21.3.1 LEACHATE HYDROLOGY

Since the site is situated on low permeability till, subsurface migration of leachate should be limited to the site area. Shallow aquifers are not reported in this area, making contamination unlikely.

The adjacent surface water in the marsh may be affected by this site. Runoff from the slopes of the escarpment and the site appears to drain through this area into the marsh and Reader Lake. Consequently, some sporadic contamination may occur during periods of rainfall and snowmelt.

21.3.2 METHANE

Based on the amount of waste deposited at this site an estimated 6.5 million cubic metres of methane gas may be produced per year.

Since waste is deposited above grade, methane gas migration should be limited. Methane gas most likely vents directly into the atmosphere with little subsurface migration.

21.3.3 WATER QUALITY

Since no wells are located in the area and waste is deposited on the edge of a swamp which is connected to Reader Lake, a sample of the marsh water at the edge of the landfill was taken.

Chemical analysis of the water indicates no sign of contamination. All parameters fall below objective recommended levels, and no unusual results were noted (see Table 18.1). The total coliform bacteria level was slightly elevated, and possibly caused by bacteria generation from waste or sludge deposited directly in the water.

21.3.4 CONCLUSION

Groundwater contamination by this site is not likely, but some sporadic surface contamination of Reader Lake Marsh may be occuring by runoff from the site. Chemical analysis showed no elevated contaminant levels in the marsh water at the time of sampling, but coliform bacteria levels were high.

21.3.5 RECOMMENDATIONS

a) No waste should be deposited within 100 m of the marsh.

b) Waste should be covered with fill regularly to avoid strewn debris and leachate runoff.

c) The construction of a berm around the buried waste is desirable.

d) Sludge from the treatment plant shold not be deposited at this site since no retention facility exists.

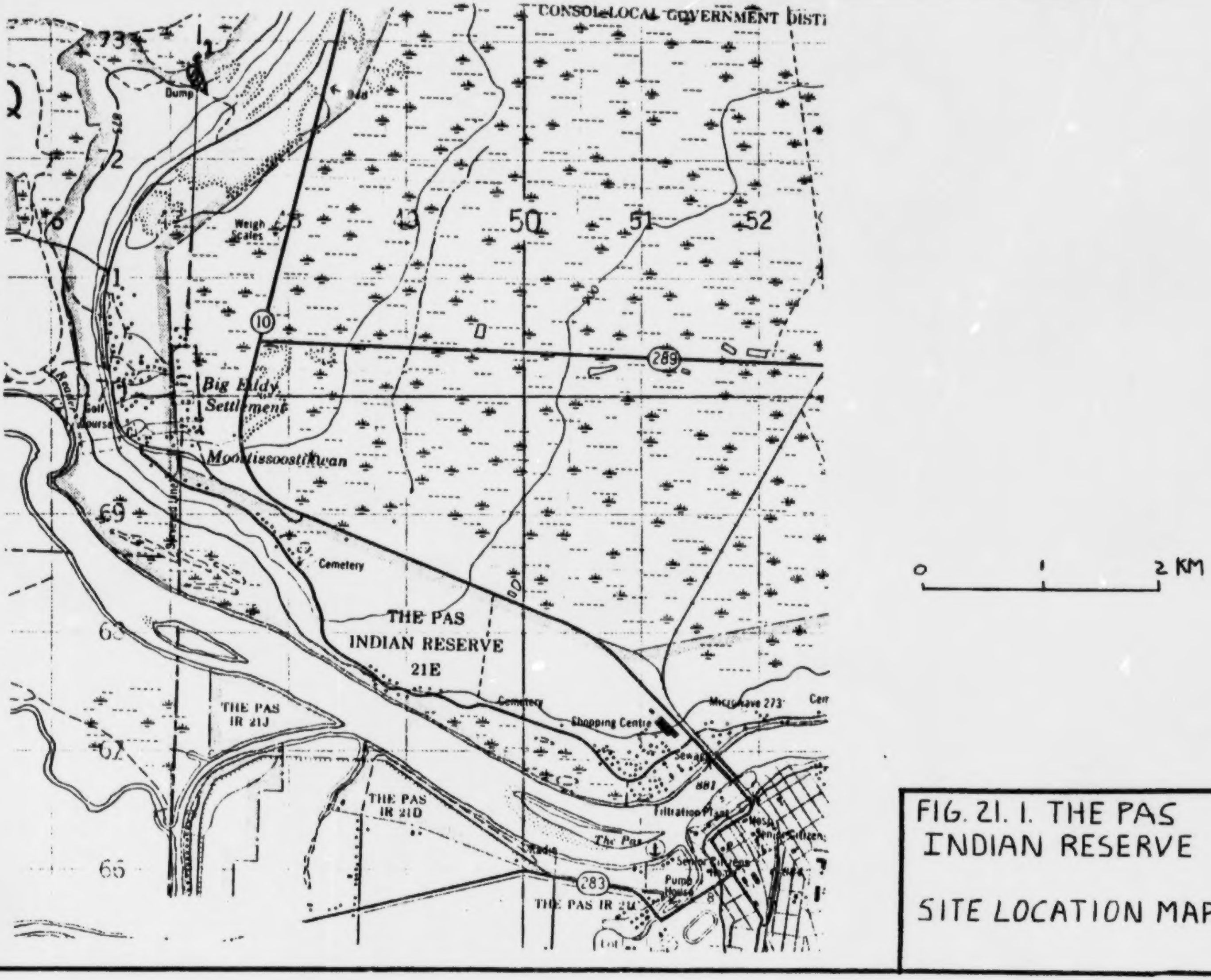

CONSOL. LOCAL GOVERNMENT DISTI
73
2
6
1
Dump
Weigh Scales
43
50
51
52
10
289
Big Eddy Settlement
Golf Course
Mooniissoostikwan
69
Cemetery
THE PAS INDIAN RESERVE 21E
THE PAS IR 21J
THE PAS IR 21D
Cemetery
Shopping Centre
Microwave 273
Sewage
881
Filtration Plant
Radio
The Pas
Senior Citizens
Pump House
283
THE PAS IR 21C
65
0
1
2 KM

FIG. 21. 1. THE PAS INDIAN RESERVE

SITE LOCATION MAP

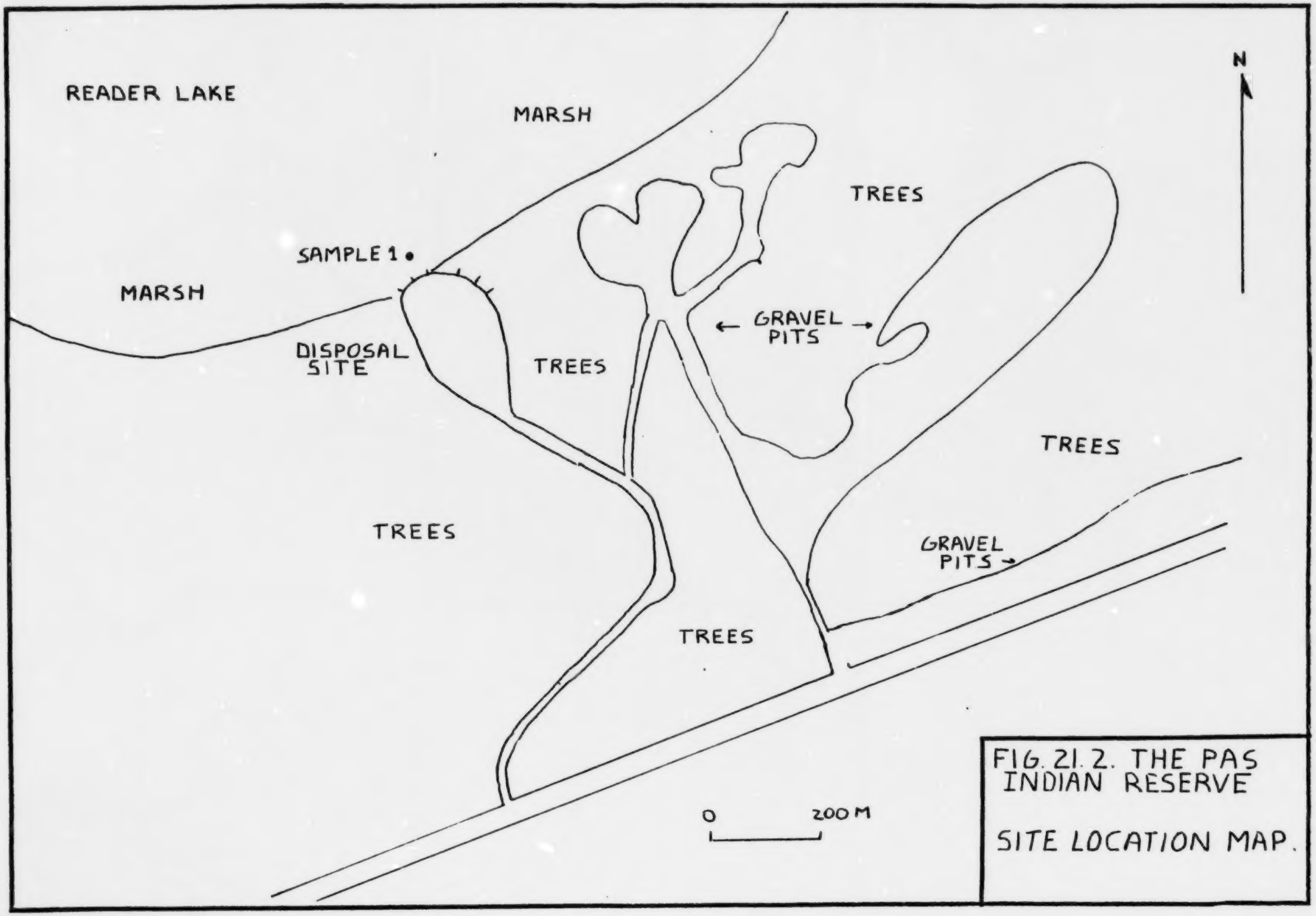

N
READER LAKE
MARSH
MARSH
SAMPLE 1
DISPOSAL SITE
TREES
TREES
TREES
TREES
TREES
← GRAVEL PITS →
GRAVEL PITS →
0
200 M

FIG. 21.2. THE PAS INDIAN RESERVE

SITE LOCATION MAP.

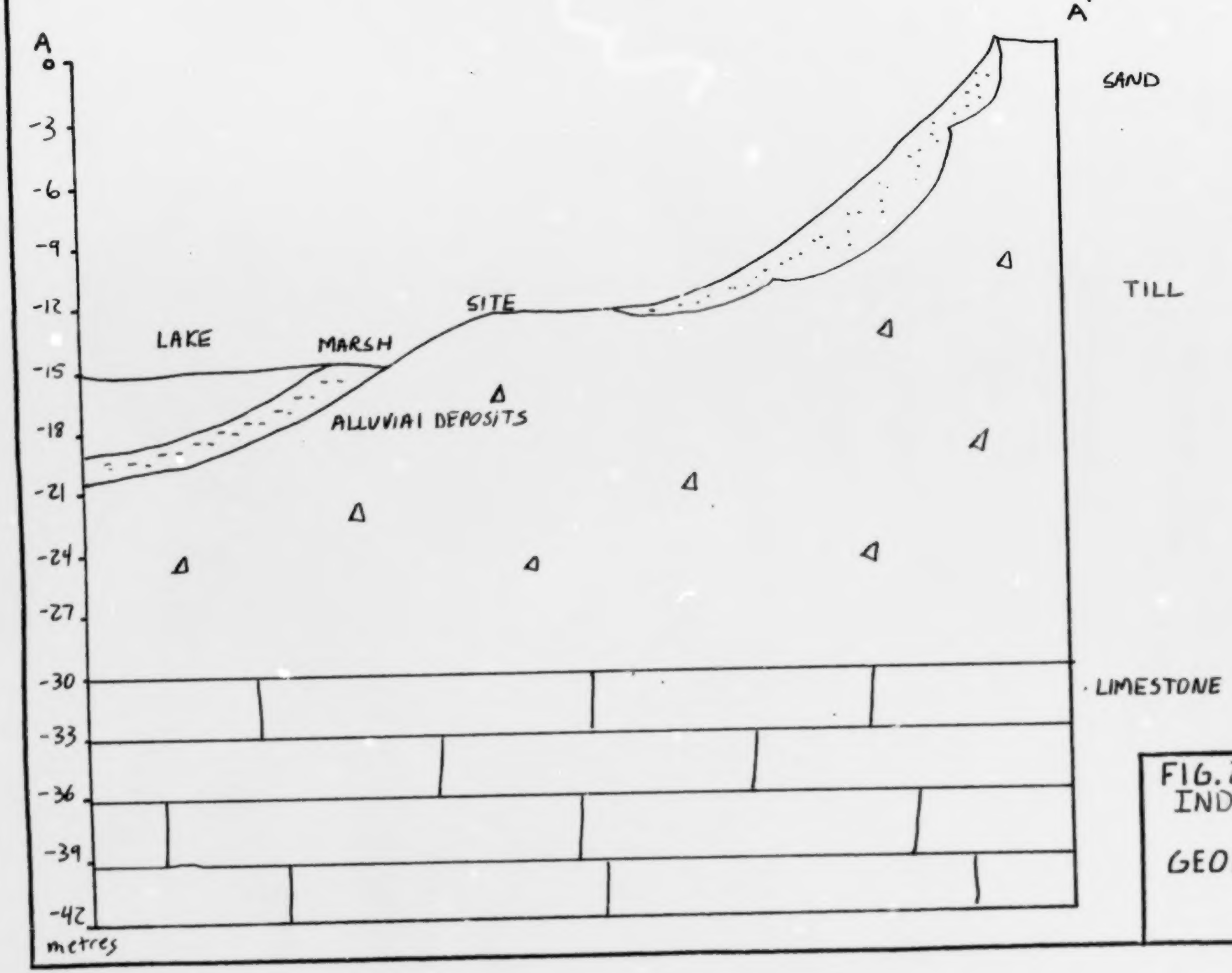

A
A'
0
-3
-6
-9
-12
-15
-18
-21
-24
-27
-30
-33
-36
-39
-42
metres
SAND
TILL
SITE
LAKE
MARSH
ALLUVIAl DEPOSITS
LIMESTONE

FIG. 21.3 THE PAS INDIAN RESERVE

GEOLOGIC CROSS SECTION

TABLE 21.1. THE PAS INDIAN RESERVE

Site Number	1			
Parameters				
Conductivity umho/cm	548			
Residue Total mg/L	360			
Residue Filt mg/L	330			
Residue Non-Filt mg/L	36			
pH units	7.15			
Alkal. Total ($CaCO_3$) mg/L	266			
Alkalinity (HCO_3) mg/L	325			
Alkalinity (CO_3) mg/L	0			
Alkalinity (OH) mg/L	0			
As (Ext.) mg/L	$<.001$			
Cd (Ext.) mg/L	$<.001$			
Cu (Ext.) mg/L	.02			
Pb (Ext.) mg/L	$<.005$			
Ni (Ext.) mg/L	$<.005$			
Zn (Ext.) mg/L	.05			
Cr (Total) mg/L	$<.005$			
Calcium (Ext.) mg/L	66.2			
Magnesium (Ext.) mg/L	32.0			
Hardness ($CaCO_3$) mg/L	297			
Manganese (Ext.) mg/L	.09			
Iron (Ext.) mg/L	1.69			
Potassium (Ext.) mg/L	<5.0			
Sodium (Ext.) mg/L	16.9			
COD mg/L	40			
T.O.C. mg/L	18.0			
Turbidity NTU	4.			
CN (Free) mg/L	$<.02$			
Kjeldnal, Total-N mg/L	.70			
NH_3-N (Sol.) mg/L	.30			
NO_3-NO_2-N (Diss.) mg/L	.01			
P-Total mg/L	.09			
Chloride (Sol.) mg/L	19			
Sulphate (Sol.) mg/L	20			
Fecal Coliform /100 mL	-			
Total Coliform /100 mL	35			

CHAPTER - TWENTY TWO -

TRAVERSE BAY

L.G.D. OF ALEXANDER

NE 26-19-7E

22 TRAVERSE BAY WASTE DISPOSAL SITE

22.1 RECONNAISSANCE DATA

The Community of Traverse Bay, Manitoba, is located within the Local Government District of Alexander 100 km north of Winnipeg, along P.T.H. 59. The waste disposal site is located 1.6 km east of the highway on Section NE 26-19-7E (see Figure 22.1).

22.1.2 PHYSIOGRAPHY

The area is located on large peninsula extending north into Lake Winnipeg. Till ridges and sandflats form a landscape 21 m above the surrounding lake level.

The till ridges feature poplar and birch stands. The site is located on a sandflat which supports pine trees exclusively. Drainage does not exist around the site; apparently infiltration of precipiation allows subsurface runoff.

22.1.3 BACKGROUND

The site serves about 200 permanent residents in the area and approximately 1500 seasonal residents in the resort area. The disposal of municipal waste and septic tank effluent has previously been reported at this site.

Water supplies consist of private wells and shared wells. Septic tanks and holding tanks are used for private sewage disposal in houses and cottages equipped with a pressure system.

Currently, the nearest residences are located about 350 m from the site along the Section Road but a new cottage development in progress north of the site will bring buildings closer to the site.

22.1.4 SITE CONDITIONS

During the site inspection on October 26, 1984, several observations were made. Access to the site is from the south, directly onto an open area used for surface disposal. The total site area is a 4.04 hectare clearing in the surrounding pine stands.

The active areas consist of an 80 m by 80 m shrubs pile, a 30 m by 30 m pile for bulky metallic waste, a 100 m by 3 m by 3 m trench for household waste, and a 5 m by 5 m open pit used for fish waste and sewage disposal. Household waste is burned and backfilled when the trench is full.

22.1.5 DRILLING AND SAMPLING

A drilling program was not undertaken at this site.

One surface water and two well samples were collected around the site area (see Figure 11.1 for locations). The analyses results are summarized in Table 22.1 and discussed in Section 22.3.3.

22.2 GEOLOGIC DATA

22.2.1 GEOLOGIC SETTING

The site is located on ridges of ice marginal deposits from the last ice age. The typical structure of these ridges consist of high calcareous till interbedded with extensive outwash features. The outwash consists of connected and disconnected beds and layers of sand and gravel (see Figure 22.2).

At the surface, the outwash forms sandflats; at depth, the sand is saturated and forms aquifers.

22.2.2 BEDROCK

Precambrian bedrock is reported in the area. The depth to contact is estimated at 60 m to 70 m beneath the site.

22.2.3 OVERBURDEN

An estimated 60 m to 70 m overburden overlies bedrock in this area. Primarily till composes the unit but up to half the thickness consist of thick sand and gravel beds.

22.2.4 GEOHYDROLOGY

The thick and extensive lenses of sand and gravel in the till form the major aquifer in this area. Recharge occurs by infiltration in those areas where the sand units are exposed at the surface, including the site area.

Both deep and shallow wells are common in this area, depending on the local thickness of till overlying the aquifer. The static water level is approximately 5-8 m beneath the site.

22.3 ENVIRONMENTAL INTERPRETATION AND ASSESSMENT

22.3.1 LEACHATE HYDROLOGY

Two possible sources of leachate generation exists at this site. The household waste may generate leachates when precipitation infiltrates the buried waste and migrates downward. Since the waste is located several metres above the groundwater table, this process occurs only intermittently during heavy rainfall and snowmelt.

Sewage disposed at this site forms the second source of leachate. The disposed sewage can rapidly migrate down through the highly permeable sand to the water table and contaminate groundwater. Since most of the sewage is from cottages in the area, the contamination from this source is seasonal.

Since both sources of leachate generations are sporadic, the extent of possible groundwater contamination is likely limited to site and areas immediately adjacent to it. To date, no wells are located in the site vicinity and existing drinkwater supplies are not likely to be affected; however, cottage development is expanding towards the site.

23.3.2 METHANE

Based on the amount of waste deposited at this site an estimated 0.5 million cubic metres of methane gas may be generated per year. Since some of the waste is burned before burial the actual quantity of methane gas generated will be a fraction of the estimate.

Methane gas migration should be limited to a distance of 50 metres, based on the permeability of the soil.

22.3.3 WATER QUALITY

Three water samples of wells around the site were taken (Figure 22.1). Water quality was found to be very good for the deeper well, fair for the shallow dug well.

The deeper well water exhibits low concentrations of ions and dissolved solid. All parameter levels are well below objective limits. A water sample from a ditch was taken from a flowing well after it had reached the surface The water was found to be excellent quality, with all parameters well below objective limits.

The third sample taken was from a house, SW 35-19-7E, and was found to be fair in quality. However, nitrate levels were three times the maximum acceptable limit. Other parameters such as sulphate and chloride were found to be slightly higher than the deep well and the surface water.

A table of parameters for each of the samples can be found in Table 22.1.

22.3.4 CONCLUSION

Since the sandflats on which the site is located serve as a recharge area for the local aquifer, this area is pollution sensitive. Although till overlies the aquifer in many parts, the geology suggests that a direct connection between the sandflats and the aquifer exists.

Leachates may affect water quality beneath the site and adjacent areas. The present development of cottages immediately north of the site will reduce the distance to the nearest residences. The associated water supplies and wells may possibly be located in the area affected by the site. The house well sampled showed elevated nitrate levels. However, the source of this contamination is more likely from the septic system of the house than from the waste disposal site.

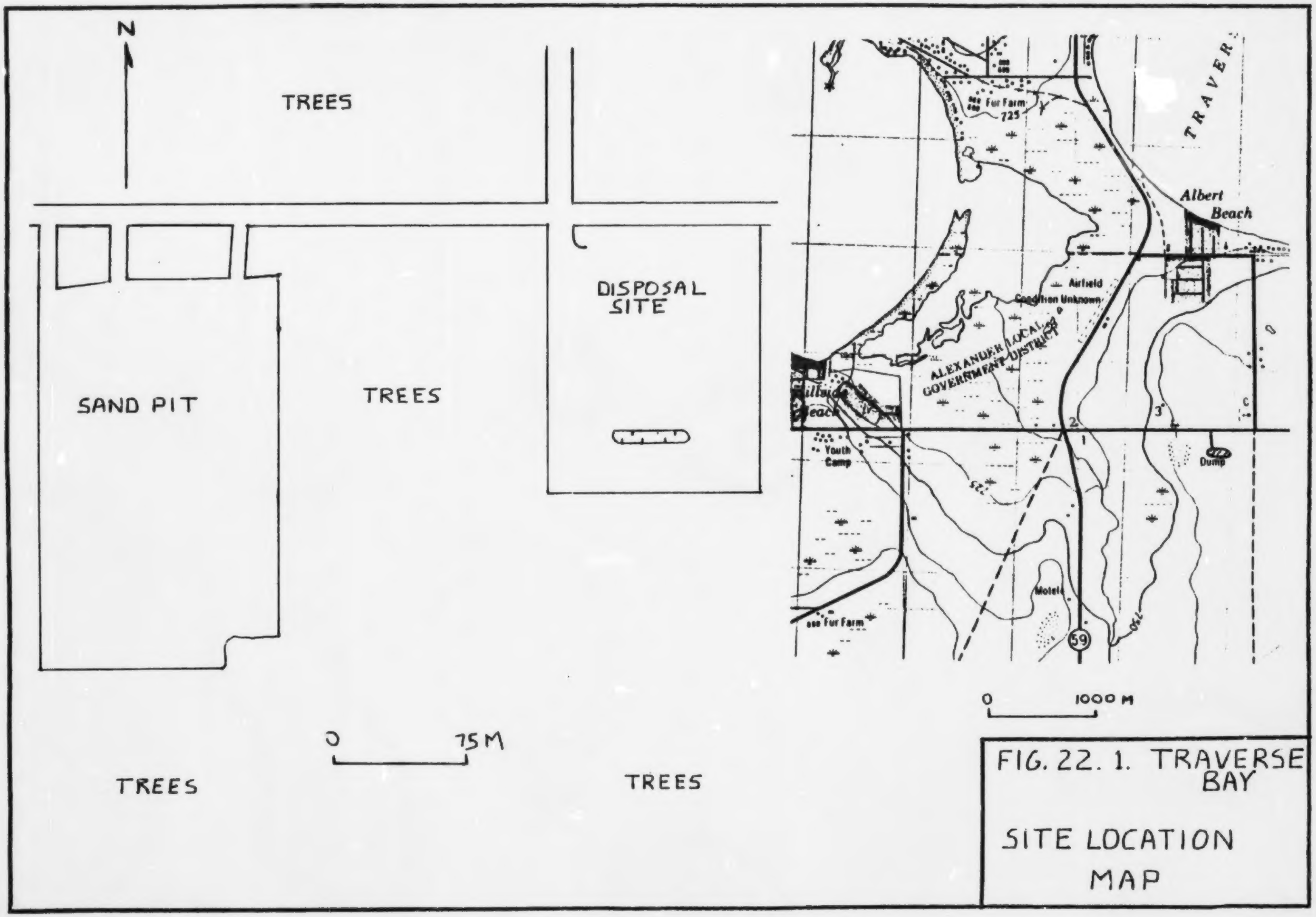
22.3.5 RECOMMENDATIONS

a) Sewage disposal should be discontinued immediately since no proper retention facility exists.

b) Monitoring wells should be installed on the site to further assess groundwater quality.

c) A sampling program should be carried out in the summer when water samples can be taken from cottage residences.

d) Due to the pollution sensitive location of this site, relocation of the waste disposal site is recommended.



N
TREES
DISPOSAL SITE
SAND PIT
TREES
0 75M
TREES
TREES
TRAVERS
Albert Beach
Fur Farm
725
Airfield
Condition Unknown
ALEXANDER LOCAL GOVERNMENT DISTRICT
Hillside Beach
Youth Camp
Dump
Motel
Fur Farm
750
59
0 1000 M

FIG. 22. 1. TRAVERSE BAY

SITE LOCATION MAP

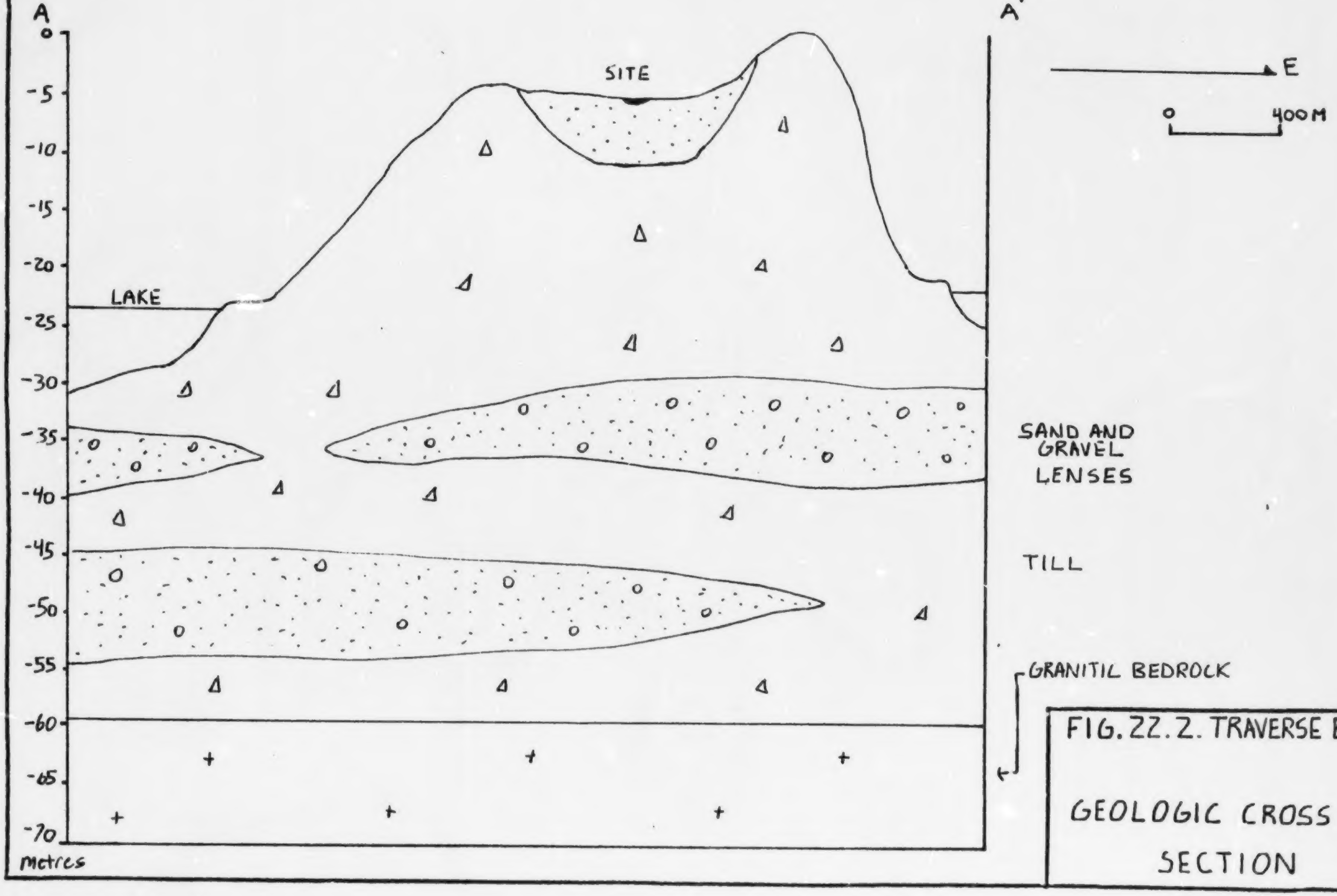

A
A'
SITE
LAKE
E
0
400M
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
-70
metres
SAND AND GRAVEL LENSES
TILL
GRANITIL BEDROCK

FIG. 22.2. TRAVERSE BAY

GEOLOGIC CROSS SECTION

TABLE 22.1. TRAVERSE BAY

Site Number	1	2	3	
Parameters				
Conductivity umho/cm	744	307	1050	
Residue Total mg/L	560	190	730	
Residue Filt mg/L	530	190	730	
Residue Non-Filt mg/L	29	<5.	<5.	
pH units	7.70	7.85	7.80	
Alkal. Total ($CaCO_3$) mg/L	194	154	290	
Alkalinity (HCO_3) mg/L	237	188	354	
Alkalinity (CO_3) mg/L	0	0	0	
Alkalinity (OH) mg/L	0	0	0	
As (Ext.) mg/L	.001	.002	<.001	
Cd (Ext.) mg/L	<.001	<.001	<.001	
Cu (Ext.) mg/L	<.01	<.01	.03	
Pb (Ext.) mg/L	<.005	<.005	<.005	
Ni (Ext.) mg/L	<.005	<.005	.005	
Zn (Ext.) mg/L	<.01	<.01	.08	
Cr (Total) mg/L	.004	<.005	<.005	
Calcium (Ext.) mg/L	102	46.1	131.	
Magnesium (Ext.) mg/L	20.7	9.54	10.9	
Hardness ($CaCO_3$) mg/L	340	154	372	
Manganese (Ext.) mg/L	.03	.03	.20	
Iron (Ext.) mg/L	.39	.51	.04	
Potassium (Ext.) mg/L	5.50	<5.0	10.5	
Sodium (Ext.) mg/L	11.2	7.20	60.4	
COD mg/L	38	12	30.	
T.O.C. mg/L	30.5	14.5	41.0	
Turbidity NTU	8	.60	.60	
CN (Free) mg/L	<.02	<.02	<.02	
Kjeldnal, Total-N mg/L	.60	.20	1.9	
NH_3-N (Sol.) mg/L	.03	.09	.89	
NO_3-NO_2-N (Diss.) mg/L	.01	<.01	35.0	
P-Total mg/L	.10	<.01	.24	
Chloride (Sol.) mg/L	20	<2.0	40.	
Sulphate (Sol.) mg/L	160	14.5	80.	
Fecal Coliform /100 mL	<1	<1	<1	
Total Coliform /100 mL	8	<1	<1	

CHAPTER - TWENTY THREE -

TREESBANK

R.M. OF SOUTH CYPRESS

NE 6-18-16W

23 TREESBANK WASTE DISPOSAL GROUND

23.1 RECONNAISSANCE DATA

23.1.1 LOCATION

The Community of Treesbank, Manitoba, is located in the R.M. of South Cypress and is approximately 174 Km west-southwest of Winnipeg along P.R. 451. The waste disposal site is located approximately 700 m west of the community on Section NE 6-18-16W (Figure 23.1).

23.1.2 PHYSIOGRAPHY

The area around the site consists of flat open prairie used as agricultural fields and pasture. The Souris River meanders as a misfit stream through an alluvial valley cut 20 to 30 metres into the flat landscape. A cut off meander loop and an Oxbow Lake, are located adjacent to the Souris River in the study area. The steep banks of the alluvial valley are overgrown with thick stands of poplar and birch, while the valley floors are covered by a combination of woodland swamps and small fields in the drier sand flats.

Surface drainage in the area is routed to the Souris River via small short gullies cut into the river bank.

23.1.3 BACKGROUND

The waste disposal site has been operating in its present location for over 10 years and in 1977 was registered with the Province as an existing waste disposal ground. Present records show that this site serves a population of 160 people. Primarily municipal waste from the Community of Treesbank and household waste from surrounding rural areas are deposited at the site.

Water supply in the area consists of private wells set into unconfined shallow aquifers.

23.1.4 SITE CONDITIONS

During the site inspection on September 12, 1984, several observations were made. The site is approximately 60 m by 8 m, with an active area of a trench, 5 m by 2 m by 1.5 m deep. Waste is deposited in this trench, burned, and covered with fill twice a year. Large bulky wastes such as cars and trucks have been pushed over the embankment of the Oxbow Lake. The site also has a separate area for chemical pesticide containers. The site is fenced on two sides, and is basically in good condition. The location of the site is good as there are no buildings in the area.

23.1.5 DRILLING AND SAMPLING

A drilling and water sampling program was not undertaken at this site.

23.2 GEOLOGIC DATA

23.2.1 GEOLOGIC SETTING

The disposal site is located at the edge of a 25 metre bluff leading down to the Souris River valley. The meandering activity of the river has historically undercut this embankment and oversteepened the natural slope. In time, earth and vegetation have slumped into the valley to form the steep bluff.

The geology exposed on the bluff suggest that the surficial deposit consists of fine sand interbedded with silt. Gravel lenses predominate at several metres depth. Beneath the gravel, clayey silts and impermeable clay become predominent (Figure 23.2).

23.2.2 BEDROCK

Hard dark shale bedrock of the Vermillion River Formation may be encountered at about 45 metres depth.

23.2.3 OVERBURDEN

Overburden consists of three major units. Permeable silty sands and gravel form a 10 metre thick surficial unit overlying an excess of 15 metres in low permeability silts and clays. This unit is separated from bedrock by over 15 metres of glacial till and shale rubble (Figure 23.3).

23.2.4 GEOHYDROLOGY

A small spring, located at about half-height on the bluff suggests that the site is situated directly above a local aquifer.

The surficial sand unit forms a shallow unconfined aquifer which is confined at depth by impermeable clays. Recharge of groundwater occurs by local precipitation. The spring confirms that the groundwater flow is from the disposal site towards the bluff.

23.3 ENVIRONMENTAL INTERPRETATION AND ASSESSMENT

23.3.1 LEACHATE HYDROLOGY

Leachates from the site infiltrate with precipitation to the water table at 10 metres depth. From here, groundwater flow directs all contaminants towards the spring in the bluff. Consequently only water between the site and the bluff is affected.

23.3.2. METHANE

Based on the amount of waste deposited at this site an estimated 0.75 million cubic metres of methane gas may be produced per year. However, since the waste is burned before burial and the site is dry, only a fraction of the above estimate will be generated. Methane gas migration should be limited to approximately 25 metres based on the permeability of the soil.

23.3.3 WATER QUALITY

Water quality of the site region will be effected only in the small area between the site and the Oxbow Lake. Some attenuation of contaminants may take place in clay layers underlying the site.

23.3.4 CONCLUSION

The environmental impact of this site is low. No drinking water and very little groundwater is affected by the site due to its proximity to the bluff and its small size. Methane gas migration is also not considered a problem since no buildings are located in the area.

In general, the site upkeep, location and present operation are good. However, some improvements can be made. Car and truck bodies previously pushed over the bluff are unsightly and may eventually litter the river valley. Further, due to the unstable slopes of the oversteepend embankment, a danger of slumping exist, thus exposing waste buried near the edge of the bluff.

23.3.5 RECOMMMENDATIONS

a) No waste should be buried or deposited within 15 metres of the bluff. This will improve bank stability.

b) Car and truck bodies should be moved from the bluff and collected in the metallic waste pile on the site surface.

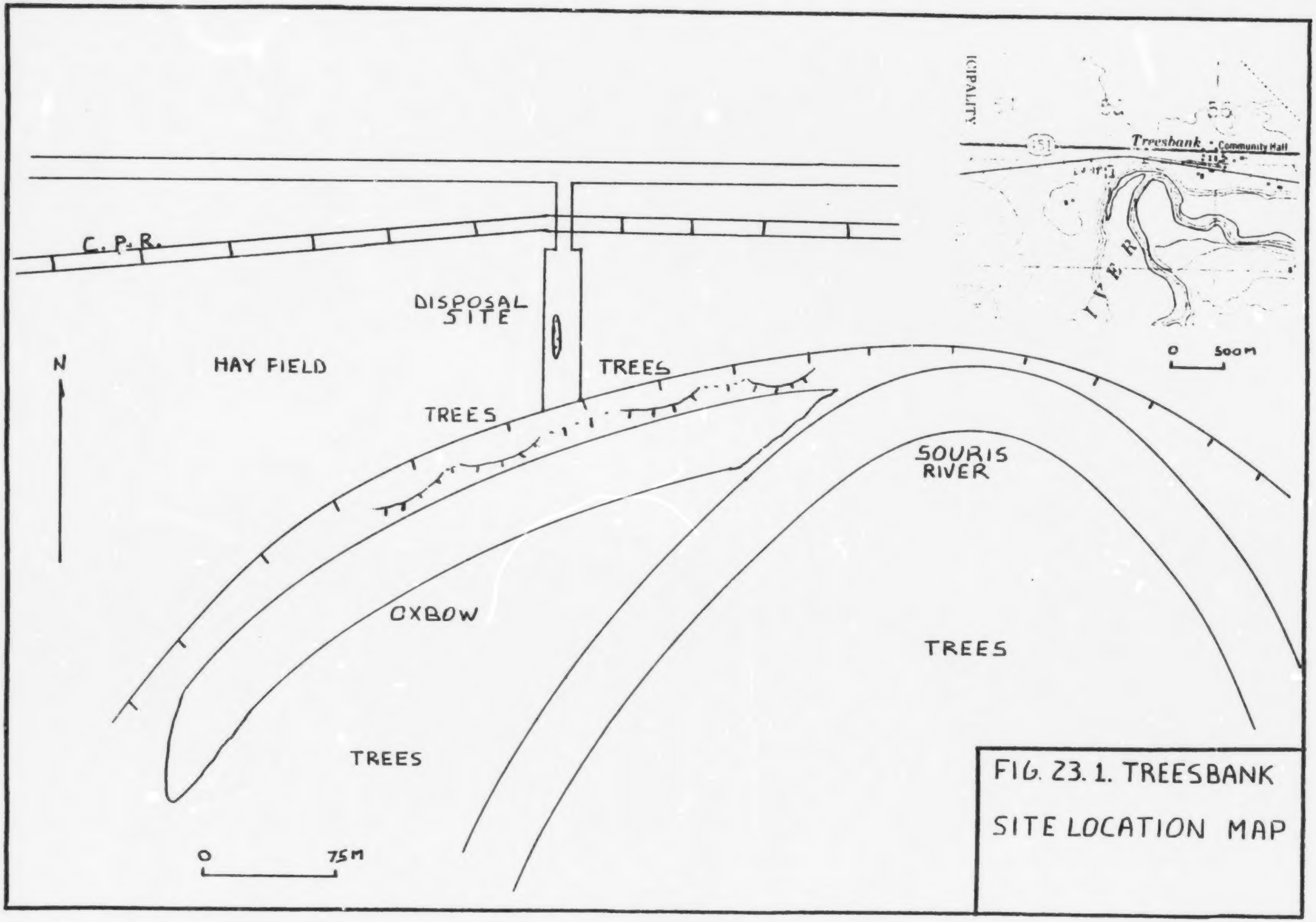

ICIPALITY
151
Treesbank
Community Hall
IVER
0 500m
C.P.R.
DISPOSAL SITE
HAY FIELD
TREES
TREES
N
SOURIS RIVER
OXBOW
TREES
TREES
0 75M

FIG. 23.1. TREESBANK SITE LOCATION MAP

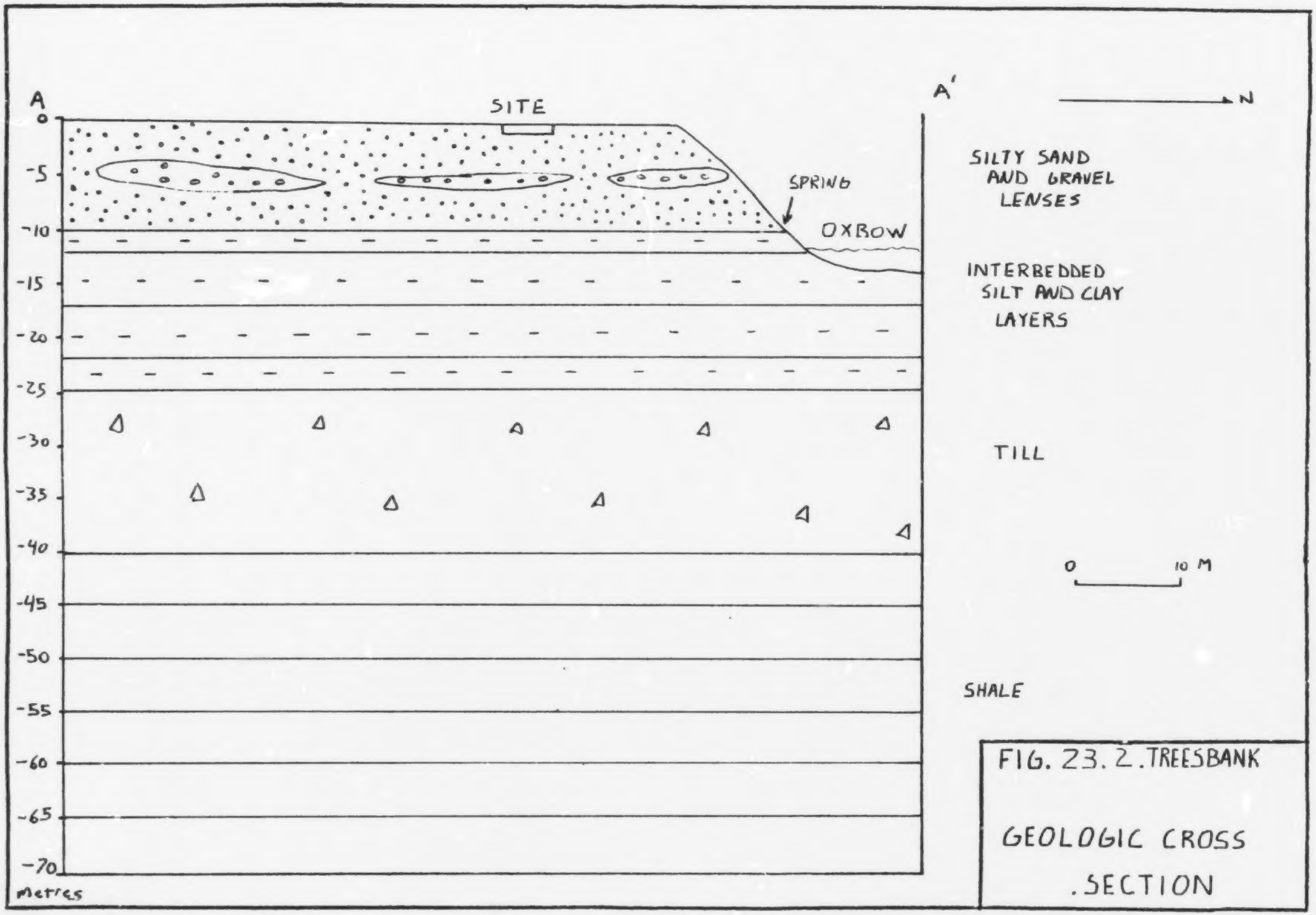

A
A'
SITE
SPRING
OXBOW
N
SILTY SAND AND GRAVEL LENSES
INTERBEDDED SILT AND CLAY LAYERS
TILL
SHALE
0
10 M
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
-70
metres

FIG. 23.2. TREESBANK

GEOLOGIC CROSS SECTION

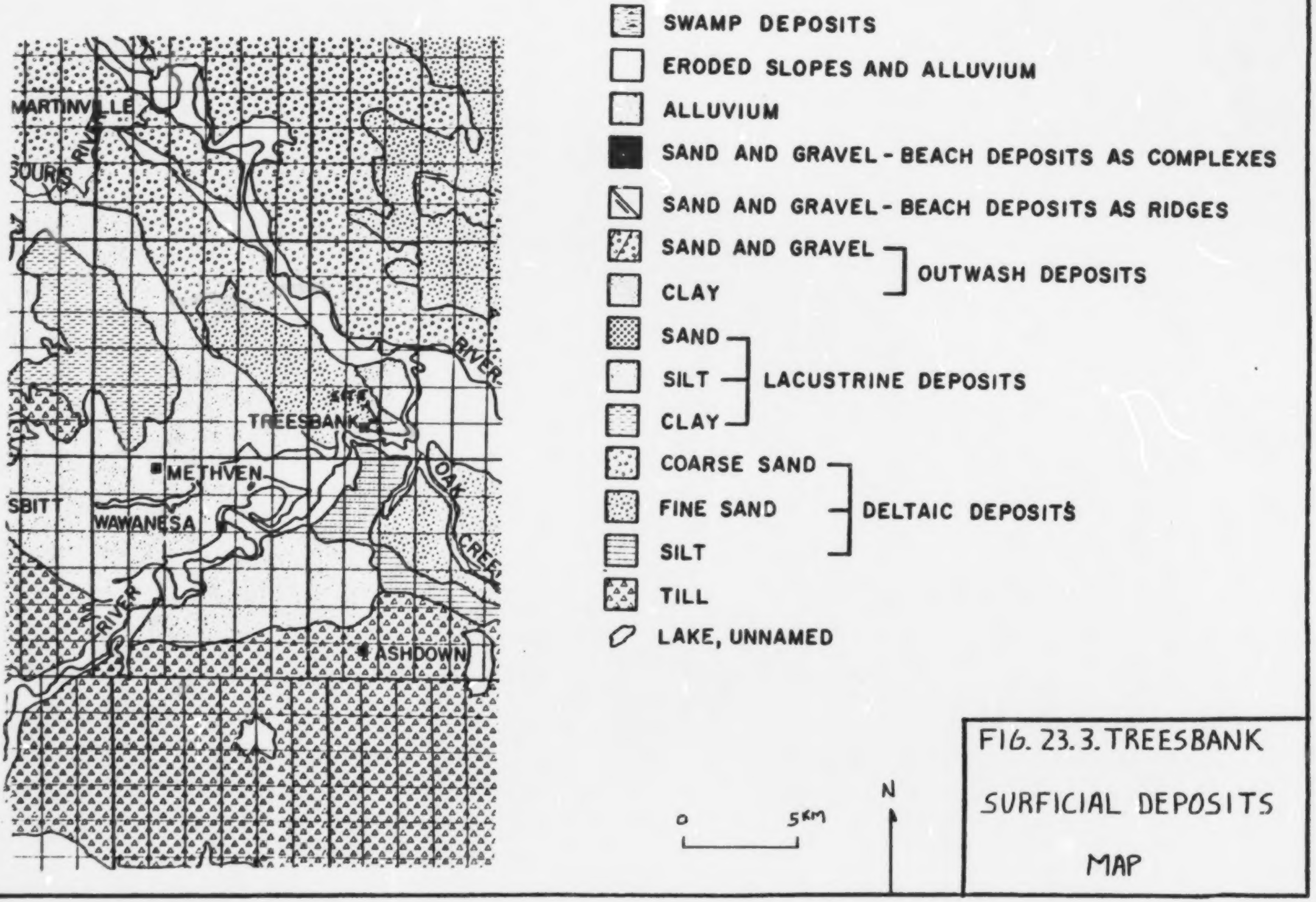

SWAMP DEPOSITS
ERODED SLOPES AND ALLUVIUM
ALLUVIUM
SAND AND GRAVEL - BEACH DEPOSITS AS COMPLEXES
SAND AND GRAVEL - BEACH DEPOSITS AS RIDGES
SAND AND GRAVEL
CLAY
OUTWASH DEPOSITS
SAND
SILT
CLAY
LACUSTRINE DEPOSITS
COARSE SAND
FINE SAND
SILT
DELTAIC DEPOSITS
TILL
LAKE, UNNAMED
0
5KM
N
MARTINVILLE
SOURIS
RIVER
TREESBANK
METHVEN
WAWANESA
SBITT
RIVER
OAK CREEK
ASHDOWN

FIG. 23.3. TREESBANK SURFICIAL DEPOSITS MAP

CHAPTER - TWENTY FOUR -

WINKLER

R.M. OF STANLEY

SW 23-3-4W

24 WINKLER WASTE DISPOSAL SITE

24.1 RECONNAISSANCE DATA

24.1.1 LOCATION

The Town of Winkler, Manitoba, is located in the R.M. of Stanley, approximately 74 kilometres southwest of Winnipeg, along P.T.H. 14. The waste disposal site is located about 1.6 kilometres east and 3.2 kilometres north of the town on Section SW 23-3-4W (see Figure 23.1).

24.1.2 PHYSIOGRAPHY

The area lies in the essentially flat and open Manitoba Lowlands. The natural relief is less than 1 metre for local undulations and the dip in topography is slight at 2 metres per kilometre to the east.

Land use consists of predominantly cultivated fields with three growth only around dwellings, windbreaks and along legal boundaries. The disposal site is grassed but surrounding lands consist of open fields.

Regional drainage is to the east with the straightened reach of Deadhorse Creek located 800 metres north of the site. Local surface runoff is in the road ditches to the north and east.

24.1.3 BACKGROUND

The waste disposal site has been operating on its present location since 1979, which at that time was registered with the

Province as a new waste disposal site. Present records show that this site serves a population of 5400 people. Primarily municipal waste from the Town of Winkler and household waste from surrounding rural areas are disposed of at this site.

Water supply for the Town of Winkler is derived from 6 deep wells located several kilometres west and south of the site.

24.1.4 SITE CONDITIONS

During the site inspection on September 14, 1984, several observations were made. The site is located approximately 4 km north of town and is situated on the junction of two Section Roads. The site is only a few metres from the roads and is approximately 120 m by 800 m in size, with an active area of 100 m by 100 m. The waste disposal area consists of surficial dumping, followed by burning and fill mixing. Waste and fill are pushed over the edge of a mound, built up to a level of 3 metres above grade. A separate agricultural chemical container disposal area is located in the north east side of the site, where can crushing operations were underway. Burned agricultural and non-agricultural chemical containers were seen in a pile on the west side of the site. The site lacks a metallic waste area as bulky metals were seen throughout the waste site. Smoke from burning waste was readily apparent and abundant.

Overall the site location is good and the site is in fair condition.

24.1.5 DRILLING AND SAMPLING

Drilling and sampling were not undertaken at this site.

24.2 GEOLOGIC DATA

24.2.1 GEOLOGIC SETTING

The area is located on the impermeable lacustrine clays and silts of glacial Lake Agassiz. Fine sands may be locally interbedded with the silts without affecting the downward permeability (see Figure 24.3).

24.2.2 BEDROCK

Shales from the Jurassic Period form the bedrock at 65 metres below grade. The shale is hard and fractured with saturated zones.

24.2.3 OVERBURDEN

Two separate units compose the 65 metres of overburden beneath the site. The impermeable clay and silt unit is estimated at 30 to 40 metres in thickness. This unit is separated from bedrock by 25-35 metres of dense glacial till (see Figure 24.2).

24.2.4 GEOHYDROLOGY

Fractured zones in the bedrock form the only aquifer in this area. The water is salty and not potable. No wells are reported in this area.

24.3 ENVIRONMENTAL INTERPRETATION AND ASSESSMENT

24.3.1 LEACHATE HYDROLOGY

Groundwater contamination from leachates generated on the site should not occur due to the impermeable nature of the subsurface.

Surficial migration of leachate is not observed nor anticipated to any great extent. Some spring runoff flows from the site into the road ditches towards Deadhorse Creek. However, since the waste is covered regularly, contamination of the ditch should not be significant.

24.3.2 METHANE

Based on the amount of waste deposited, an estimate of 7 million cubic metres of methane gas per year may be generated at this site. However, since most of the waste is burned before burial the actual quantity of methane gas generated will only be a fraction of the estimate. Methane gas migration from the site should be limited, since the waste is deposited above grade. Methane gas most likely vents directly into the atmosphere with little sub-surface migration.

24.3.3 WATER QUALITY

The confined bedrock aquifer in the site area is unpotable due to its naturally high salt concentration.

24.3.4 CONCLUSION

This site poses a very low environmental impact. Groundwater and surface waters are not likely affected by this site. Methane gas migration is not considered a problem since no buildings are located around the site. Four farm yards located within 1.5 km east of the active site area may be affected by low smoke drift from burning refuse.

24.3.5 RECOMMENDATIONS

a) Chemical pails should not be burned since hazardous fumes may result.

b) Separate areas for shrubs and for metallic wastes should be established.

c) A berm or greenbelt should be constructed between the road and the site to avoid runoff entering ditches.

d) A tree windbreak along the east and south border of the site is desirable to avoid smoke drift.

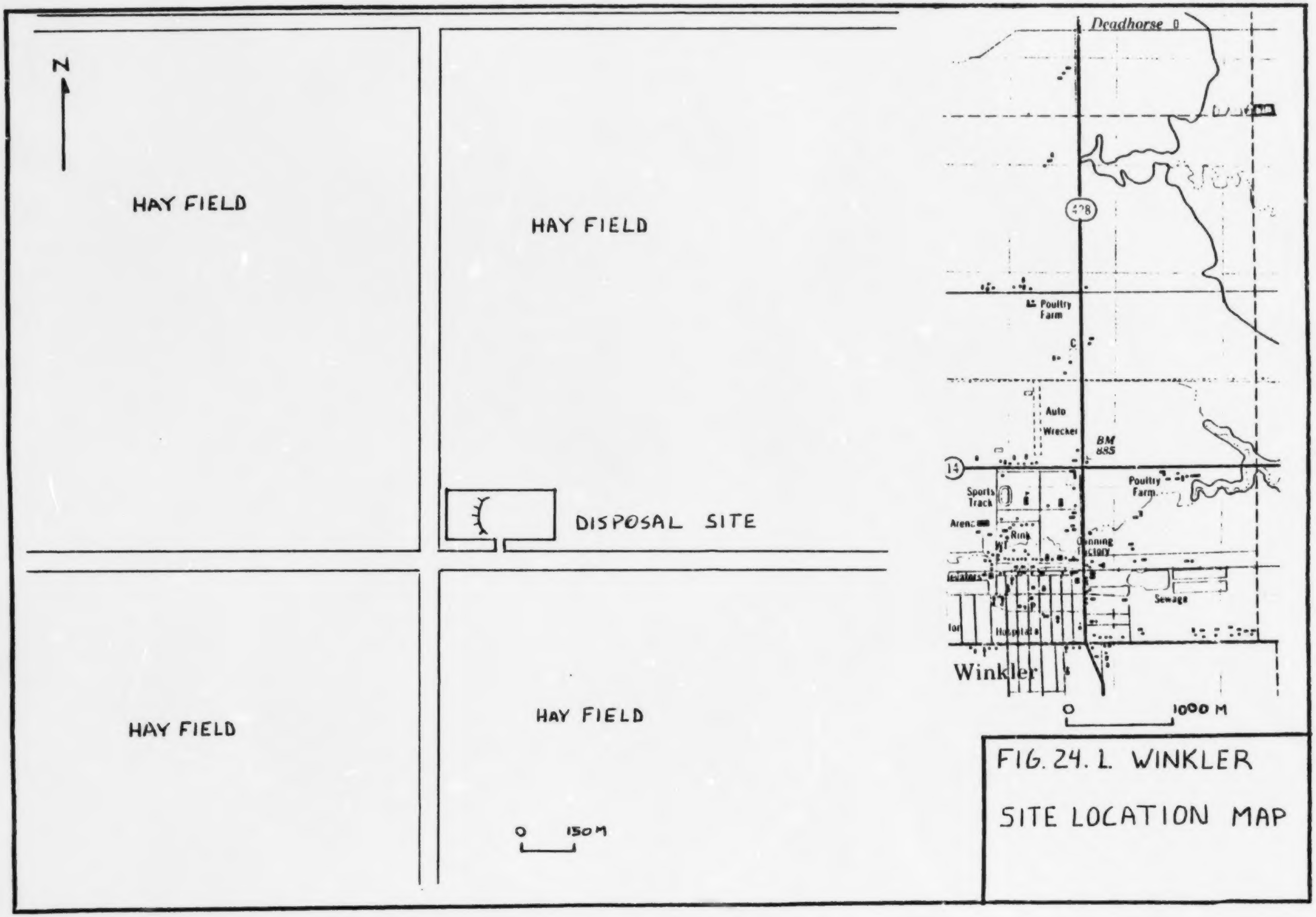

N
HAY FIELD
HAY FIELD
DISPOSAL SITE
HAY FIELD
HAY FIELD
0 150M
Deadhorse
428
Poultry Farm
Auto Wrecker
BM 885
14
Poultry Farm
Sports Track
Arena
Rink
WT
Canning Factory
Sewage
Hospital
Winkler
0 1000 M

FIG. 24.1. WINKLER
SITE LOCATION MAP

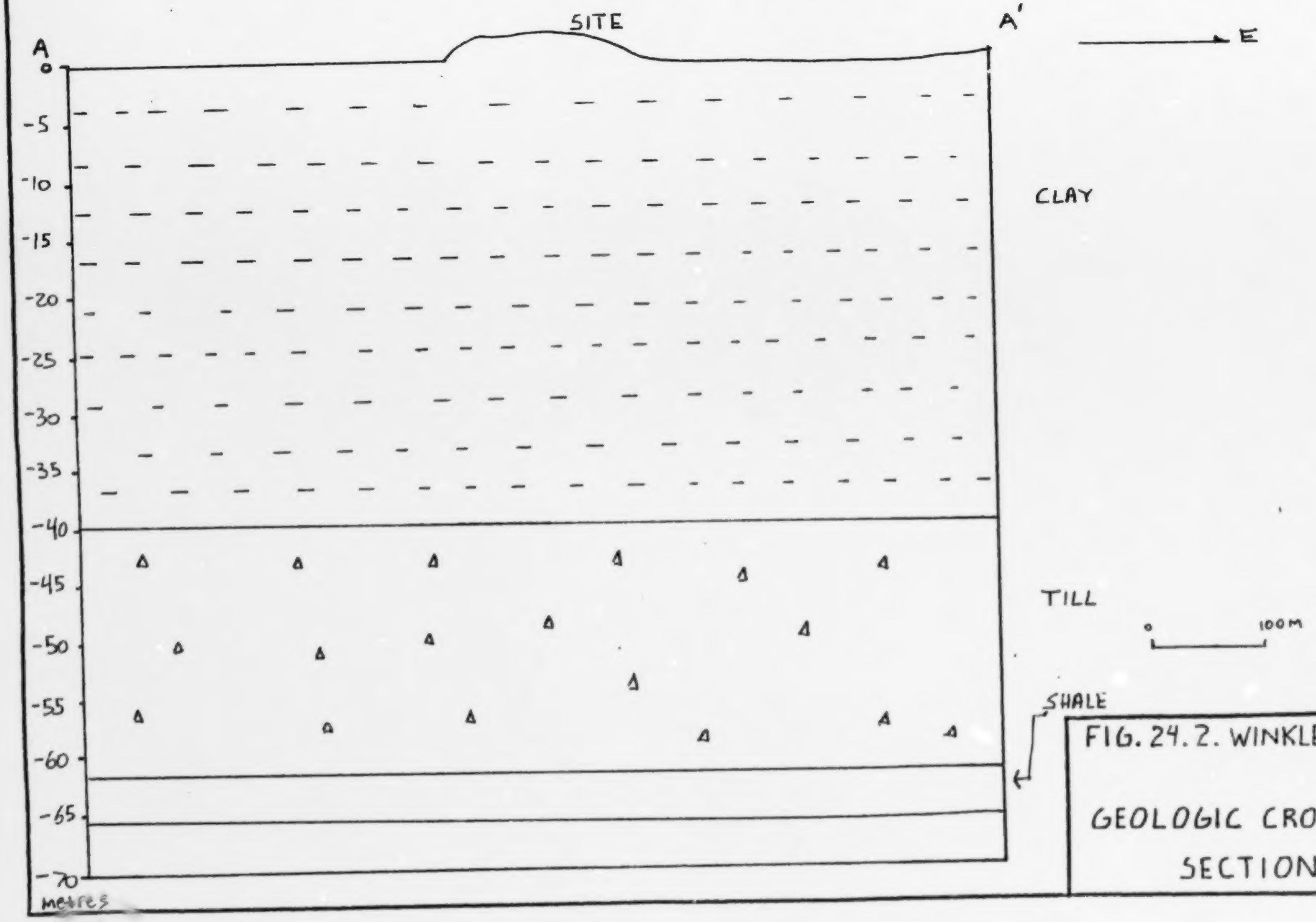

SITE
A
A'
E
CLAY
TILL
SHALE
0
100M
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
-55
-60
-65
-70
metres

FIG. 24.2. WINKLER

GEOLOGIC CROSS SECTION

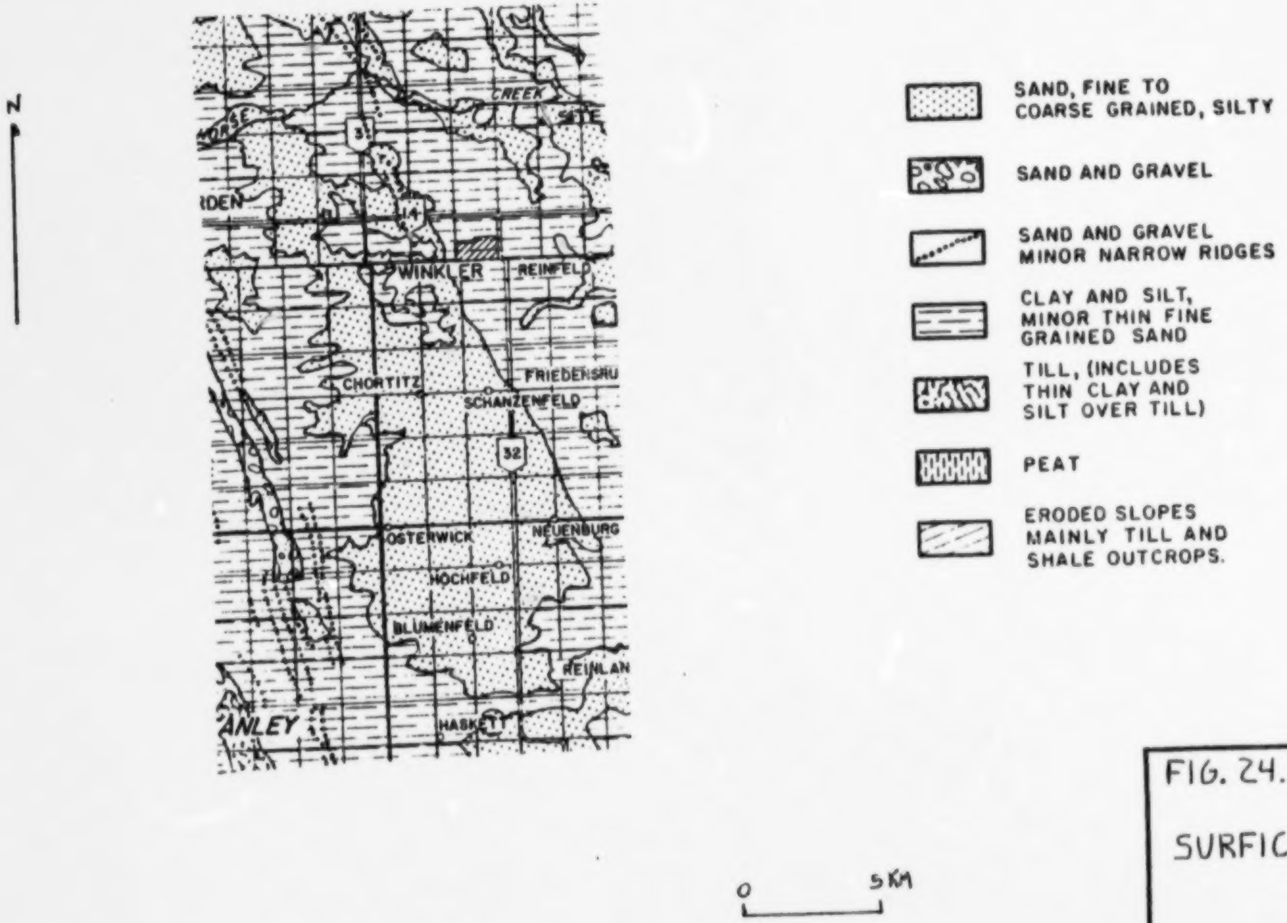

N
CREEK
3
14
32
WINKLER
REINFELD
CHORTITZ
FRIEDENSRU
SCHANZENFELD
OSTERWICK
NEUENBURG
HOCHFELD
BLUMENFELD
REINLAN
HASKETT
ANLEY
IDEN
SAND, FINE TO COARSE GRAINED, SILTY
SAND AND GRAVEL
SAND AND GRAVEL MINOR NARROW RIDGES
CLAY AND SILT, MINOR THIN FINE GRAINED SAND
TILL, (INCLUDES THIN CLAY AND SILT OVER TILL)
PEAT
ERODED SLOPES MAINLY TILL AND SHALE OUTCROPS.
0
5 KM

FIG. 24.3. WINKLER

SURFICIAL DEPOSITS

MAP